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Methods for Constructing Smooth-Riding Bituminous Surfaces

By C. N. Conner*

In this article Mr. Conner discusses the usual construction methods employed in surface treatment, penetration macadam, mixed-in-place, premixed-laid-cold, and premixed-laid-hot types, with the results obtained with each. The articles is based on work done by him and published by the Highway Research Board, of which R. W. Crum is director.

PRINCIPAL among the requirements for safe and easy operation of automobiles and trucks is a riding surface of regular contour. To obtain and retain a regular contour the surfacing must be built regular at the time of construction on a base which is free from irregularities. All base materials are not suitable for bituminous surfaces; and the selection of suitable bases requires good judgment.

There are three major requirements for obtaining and retaining a regular or smooth-riding bituminous surface:

(a) Proper design of mixture in the laboratory and field.

(b) Proper construction methods.

(c) Proper maintenance methods.

This article deals principally with "b"—Proper Construction Methods—and points out the tendencies towards and the methods for building smooth-riding bituminous surfaces.

The four general types of bituminous surfaces are:

I—Surface Treatment Types and Penetration Macadam.

II—Mixed-In-Place Types.

III—Premixed-Laid-Cold Types.

IV—Premixed-Laid-Hot Types.

Type I is being constructed by the state highway departments of Maine, Indiana, Virginia and North Carolina. Type II by the state highway departments of California, New Mexico, South Carolina, Wisconsin and Minnesota. Type III by the state highway departments of Indiana, Maryland and Pennsylvania. Type IV by the state highway departments of California, Oklahoma, South Carolina and North Carolina.

*American Road Builders' Association

SURFACE TREATMENTS: SPREADING COVER FROM TRUCK

SURFACE TREATMENT
Spreading cover material by hand methods. Note large labor force and the transverse spreads which may cause ridges

I—SURFACE TREATMENT TYPES

1. USUAL CONSTRUCTION METHODS AND RESULTS

METHODS. The method as practiced generally is to smooth up and patch the old gravel or macadam surface and apply one, two or possibly three applications of bitumen from a power distributor. One or each of these applications is covered with sand, gravel, stone chips, or slag chips. The cover is spread by hand shovels from piles of material previously placed along the roadside at regular intervals. Traffic does the compacting.

RESULTS. If the base to be treated is not well compacted at the time of treatment, more failures and consequent irregularities will occur than if good compaction has been secured prior to treatment.

If the surface of the base is irregular in contour at the time of treatment, these irregularities will still be apparent in the finished surface.

If the cover material is spread non-uniformly in shallow ridges; or transversely instead of uniformly, longitudinally or diagonally; the finished surface will, to a more or less degree, reflect these irregularities.

SURFACE TREATMENT; BROOM DRAG
Various types of drags add greatly to the riding qualities of bituminous surface treatments

2. IMPROVED CONSTRUCTION METHODS AND RESULTS

METHODS. Careful construction methods require that a previously untreated surface must pass through a year or more under traffic and be subjected to seasonal variations of climate. The weak places in the surface and subgrade are corrected during this period. Before treatment with bitumen, the surface is finally evened up by lightly scarifying and reshaping, or by patching depressions.

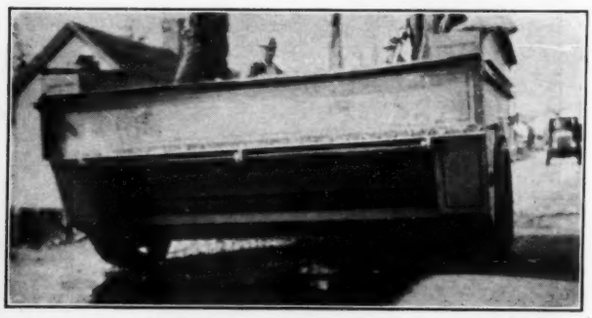
If the surface has not previously been treated, a prime coat of bitumen is applied, and is allowed to penetrate the surface. A second application of bitumen is then made, hot or cold, and immediately covered with suitable cover material.

Care is exercised in the spreading of this aggregate to obtain a uniform distribution. Chip spreaders of various types instead of hand shovels are not uncommon and are said to give good results. Following the spreading of the cover material, it is dragged with various types of light drags. Compaction may be done by a roller or by traffic or by both.

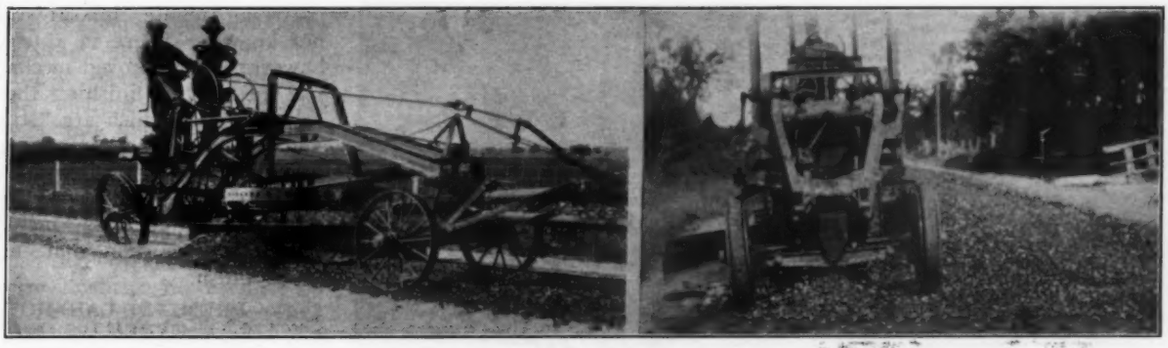
RESULTS. Because the old surface was well compacted and bonded, fewer failures occur in it. Because the old surface was carefully shaped prior to treatment, few irregularities in these relatively thin surfaces appear. Because the cover material is dragged, a quicker drying surface is obtained, less cover material is wasted at the roadside by traffic, and a smoother riding surface results because small holes

SURFACE TREATMENT
Brush drag used for smoothing surface and spreading cover

SURFACE TREATMENT
Sled drag used for cutting and smoothing surface



SURFACE TREATMENT
Several types of chip spreaders are giving a uniform distribution of stone and reducing loss of material.



MIXED-IN-PLACE

Mixing gravel and bitumen with blade grader. Mixing stone and bitumen with blade grader.

in the surface have been filled with well-coated cover material.

Smooth-riding surfaces of this type are the result of careful and intelligent construction methods. Rough-riding surfaces frequently are the result of carelessness in construction or an unwillingness to try out methods which have been successful elsewhere.

II—MIXED-IN-PLACE TYPES

Because this type is new, the usual construction methods represent present good practice and give good results. They are the outcome of field experiment and experience.

CONSTRUCTION METHODS AND RESULTS

METHODS. Briefly stated, the methods consist of alternative applications of bitumen to the loose surface aggregate, and the mixing of this bitumen with this aggregate in place on the road surface.

The bitumen is applied from power distributors and the mixing is done by harrows, road bladers and drags. In certain instances all three pieces of equipment are used; in others, the harrow may be omitted. The road blader has been found to be the most effective piece of equipment for mixing and smoothing. Final compaction is done by a power roller or by traffic or by both.

RESULTS. Reports show that at the time of completion, and in certain instances for a year or more thereafter, bituminous surfaces of the mixed-in-place type are smoother-riding than the average surface treatment types or the pre-mixed types.

In some localities untreated gravel and sand-clay roads have been notorious for their good riding qualities immediately after blading and dragging; this same process of blading and dragging produces like results in a bituminous surface of the mixed-in-place type, but the bituminous surface so prepared retains its regularity for a much longer period than the untreated gravel and sand-clay surfaces.

III—PREMIXED-LAID-COLD TYPE

This type of surface includes all bituminous mixtures which are prepared hot or cold but which are laid at atmospheric temperatures. Included in this class are many patented or controlled mixtures, such as Amiesite, rock asphalt, and mixtures of bitumen and stone, slag, sand or gravel.

1. CUSTOMARY CONSTRUCTION METHODS AND RESULTS

METHODS. In general, the construction of the surface includes dumping on dump boards, spreading and raking by hand tools, followed by compaction with a power roller.

RESULTS. The resulting surface at the time of finishing is reasonably smooth but not as smooth as

PRE-MIXED LAID COLD

These mixtures are relatively stiff and require hand methods, especially when the aggregates are coarse

PRE-MIXED LAID COLD; COARSE AGGREGATE TYPE

Showing hand methods necessary for mixtures laid at atmospheric temperature

PRE-MIXED LAID HOT; FINE AGGREGATE MIXTURE
Showing spreading, raking and the straight-edge. The operations by machine or hand methods are essential to all bituminous concretes, whether of the hot or cold-laid type

the surface-treated and mixed-in-place types, which included blading and dragging in their construction processes.

The regularity of surface is dependent on the skill of raker and roller man, and the frequent patching which follows continuous testing with a straight edge. The personal equation which is typical of all hand work is more variable in quality and does not produce the accurate results which are typical of those provided by mechanical equipment.

2. IMPROVED CONSTRUCTION METHODS AND RESULTS

METHODS. Finishing machines similar to those used on Portland cement concrete pavements have not been tried on the coarse cold mixtures, such as Amiesite and similar coarse mixtures.

Good results and smooth riding surfaces have been obtained in the construction of rock asphalt surfaces which contain fine-graded aggregates such as are found in Kentucky.

The method, briefly, is to spread the material, rake and lute it before compaction with the power roller. After initial compaction with the power roller the surface is planed with a blade grader or heavy drag. Additional material is added in small quantities from a truck as required. The processes of rolling and planing are continued until a surface of uniform density and surface regularity is obtained.

The results justify the methods. Whether or not these methods are applicable to stiffer mixtures or coarse-aggregate mixtures is not known. There is a need, however, for improved mechanical methods of finishing those cold mixtures which are "stiff" and whose finished-surface regularity does not usually compare favorably with those whose construction methods include blading, dragging and machine finish.

IV—PREMIXED-LAID-HOT TYPES

1. USUAL CONSTRUCTION METHODS AND RESULTS

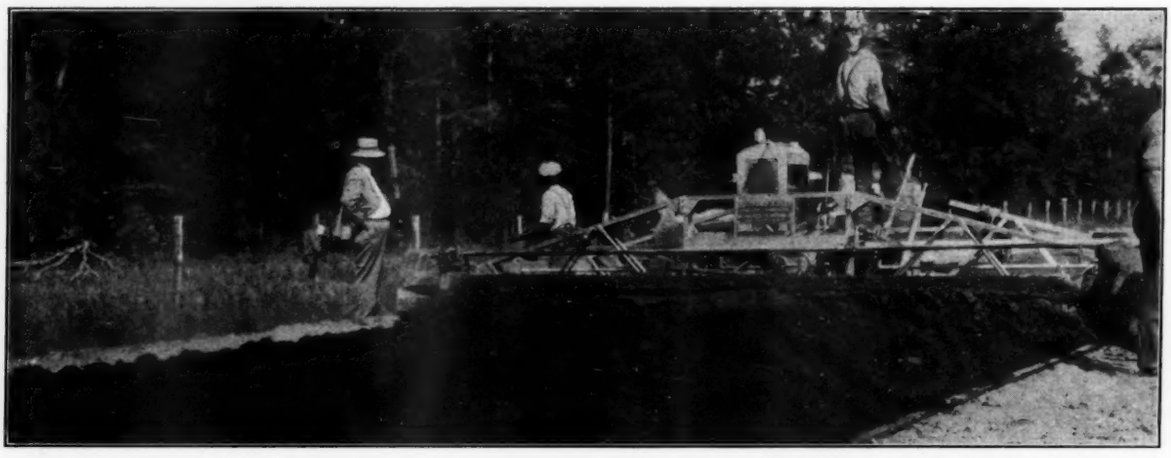
METHODS. Included in this are such mixtures as fine and coarse-aggregate bituminous mixtures. The usual construction processes on the road are dumping the hot mixture on dump boards from trucks, spreading and raking by hand, and compaction with power rollers. Irregularities in the surface are detected by straight edge and are usually corrected prior to final rolling. In some instances a final straight edging is done after the surfacing has been completed. Surface irregularities discovered at this time are necessarily corrected by patching. This is not a desirable procedure and is frequently distasteful to both engineer and contractor.

RESULTS. The personal skill of the spreader, the raker, the roller man and the inspector with the straight edge are the determining factors for regularity of surface at the time of construction. For this reason the riding qualities of the surface on rural highways are frequently not as good as machine finished Portland cement concrete surfaces.

2. NEW CONSTRUCTION METHODS AND RESULTS

METHODS. Within the past three years mechanical spreaders and finishing machines have been tried out and used primarily to reduce the labor costs on these items of work.

The hot bituminous mixtures are dumped or placed in spreaders devised for that purpose. Some of the methods include mechanical instead of hand-raking. Finishing has been done with the two principal types of finishing machines commonly used for Portland cement concrete pavements.



PRE-MIXED LAID HOT
The finishing machine, used for ten years on cement concrete, is now used with good results on bituminous concrete

In the foregoing method of finishing, several details are being worked out, such as artificial heating of the spreader boxes and finishing machines, form setting, and others.

RESULTS. All reports agree that a smoother riding surface is obtained by machine finish than by hand finish. The improvement is represented by the results of field measurements with roughometer and straight edge. Back patching is greatly reduced and the finished surface shows a reduction of roughness by as much as one-half and two-thirds of that found in hand-finished surfaces.

PRE-MIXED LAID HOT
Coarse aggregate mixture, showing customary hand methods

CONCLUSIONS. 1.—Notable improvement in the riding quality of bituminous surfaces has been obtained by mechanical finishing instead of by hand finishing.

2.—Stiff, sticky or cold mixtures containing coarse aggregate are more difficult to finish by mechanical equipment than mixtures which are easily manipulated.

3.—The cost of finishing bituminous surfaces by mechanical equipment is less than by hand methods on projects which are of sufficient size to justify the use of mechanical finishing equipment.

4.—Density and uniformity in mixture of the compacted surface is equal to the results from hand methods.

5.—There will be an increase in the use of mechanical equipment for finishing all types of bituminous surfaces.

Effect of Chlorination of Sewage on B. O. D.

This important contribution presents data collected at the Sanitary District of Chicago, where the chlorination of sewage was studied with special reference to the effect of such chlorination upon the biological oxygen demand. These studies included bottle experiments in the laboratory and full-scale chlorination procedure at the Des Plaines Treatment Works. It was found that the greatest reduction in the B.O.D. of the sewage by chlorination was with 20 days incubating but that the percentage reduction was greatest during the shorter periods of incubation. Thus the two-day B.O.D. was reduced about 25% whereas the 20-day B.O.D. was reduced 17%. An average of 10.9 p.p.m. chlorine was utilized to produce a residual of 0.2 p.p.m. The average reduction in the B.O.D. was 24.7%. A consideration of the B.O.D. of sewage indicates that chemical oxidation occurs quite rapidly whereby the reduced substances are oxidized as in organic reactions. The oxidation of organic matter, however, is far slower. A study of the effect of chlorination upon the B.O.D. values, therefore, involves a consideration of these complex reactions. Tests made with large doses of chlorine indicate that the reduction of organic nitrogen by chlorination was not marked, although nitrogen in the form of ammonia was reduced to considerable extent. It was concluded by the authors, therefore, that this reduction in nitrogen could not account for the effect of chlorination upon the B.O.D. of chlorinated sewage and that more complete studies of the actual chemical changes which occur in chlorinated sewages are needed.

It was found in these tests that there is a lag in the development of oxidizing bacteria in the incubated samples, but that after 48 hours an acceleration in the rate of growth occurs, so that finally the number of bacteria present in the incubated chlorinated samples exceeds that of the controls. This accounts for the low B.O.D. of chlorinated samples when incubated for only two or three days, but indicates that reliable results are secured for five-day periods of incubation, or longer.

A discussion of the paper by Mr. Enslow indicates that the reduction in B.O.D. can not be attributed to the oxidative effect of chlorine, because the actual reduction in B.O.D. indicates the reaction of four times the quantity of oxygen which is supplied by the nascent oxygen hypothesis. It also was pointed out that, when chlorine reacts with amino compounds, antiseptic compounds are produced. It was finally concluded that the chlorination of sewage for the purpose or reducing B.O.D. would not supplant the biological process, but that, under certain local conditions, chlorination serves a very useful purpose of enabling the efficiency of overloaded sewage treatment plants being increased, such as during periods of low stream flow.

Abstract by C. R. Cox, in "Public Health Engineering Abstracts" of a paper by F. W. Mohlman, E. Hurwirtz and C. C. Ruchhoft before the Eleventh Texas Water Works Short School.

Recarbonation Equipment for Manhattan, Kansas

Manhattan, Kansas, has recently installed a recarbonation equipment, the first in that state, as an adjunct to its water softening plant. The supply of the city is from wells and is hard and contains considerable iron; but the softening plant, with the recarbonation equipment for preventing after-precipitation, enables it to deliver an excellent grade of water to the consumers. The recarbonation equipment was furnished by the International Filter Co. and burns natural gas to produce the carbon dioxide.

The Dewatering of Sewage Screenings*

Descriptions of the various methods employed for dewatering by pressing and by centrifuging at various plants, with results obtained. Amount, character and analyses of screenings produced at a number of cities.

By Kenneth Allen†

The disposal of sewage screenings is not often a difficult problem in the case of a small installation and where there is land available where they can be buried in trenches, plowed under or merely covered, to prevent odors, fly-breeding, etc.; but as the volume increases and land becomes more restricted it presents difficulties that may be very perplexing.

The character and the amount of screenings per million gallons of sewage naturally varies between wide limits with the character of the sewage and the fineness of the screen. At one plant there will be found a large percentage of paper; at another fecal matter will predominate; at another vegetable kitchen wastes and at another sticks, twigs and leaves, depending on the season. With a normal domestic sewage the screenings will be composed largely of paper and feces, both of which will diminish in amount in stale sewage by disintegration.

In general, the fine screenings from normal city sewage usually amount to 15 to 25 cu. ft. per million gallons of sewage, weighs 50 to 60 lbs. per cu. ft. and contains 75 to 90% water and 80 to 90% volatile matter (dry basis). They are generally so wet as to be "sloppy" but can be handled with a spade.

They are difficult to burn when containing over 70 or 75% moisture, and the greater the reduction in this percentage the longer they may be stored without giving off objectionable odors and the more readily is combustion effected. By Table II. the calorific value of Brockton screenings is given as 9345 B.t.u. per lb. If this is typical of fine screenings in general, the thoroughly dried material would afford a fuel of at least two thirds the value of good coal.

Screenings can be disposed of with due regard to sanitation:

a. By burying in trenches prepared in advance.
b. By mixing and disposing of with the city garbage.
c. By digesting, spreading and plowing under.
d. By dewatering, and burying, plowing under or burning.

Burying, in the case of all but small plants, is open to the objection that it requires considerable land and manual labor.

Disposal with garbage is often the most practicable method; but where it is to be incinerated, the moisture content demands a thorough mixing with sufficient added combustible rubbish.

Digested screenings are relatively inoffensive, and although containing perhaps 95% moisture, may be disposed of by drying on beds to about 70% moisture, by spreading on the land and plowing under, or merely used as fill.

At the Milwaukee works, experiments in digesting screenings have been carried on for over a year, and other experiments on screenings from Plainfield, N. J., have been made by Dr. Rudolfs at the New Jersey State Agricultural Experiment Station, both with promise of success if carried out under proper control. Careful, competent supervision appears to be necessary to bring about active and inoffensive decomposition, involving the proper seeding, temperature and pH control. Moreover, suitable provision for final disposal by drying or otherwise, involving additional land, must be made and in a built-up section this may not be practical.

For these reasons some method of rapid preliminary de-watering to not over 70% moisture seems desirable in the majority of cases. There are two general methods of accomplishing this: (1) by pressing, and (2) by centrifuging.

PRESSING

Coarse screenings from racks, cages, etc., have been pressed at a number of plants for a good many years. The presses have usually been of the "cider" type, operated by hand or by hydraulic power.

At *Washington* a hydraulic press of this type 24 in. in diameter, was installed in 1906, operating under a pressure of 105 to 115 lbs. per square inch, requiring two men for each eight-hour shift. It is understood that this press has stood up well under service and given good satisfaction. In the fiscal year ending June 30, 1929, 1,905,839 lbs. screenings were pressed, varying from 4,153 to 7,974 lbs. per day and averaging 5,221 lbs; the weights being of the dewatered material, which contains about 85% moisture.

Favorable results were secured at Washington where coarse screenings were put through a hydraulic press and then burned in a small Decarie incinerator used as a hot water heater for the building. Their volume was reduced about 60% in the press. About three pressings were made per hour during dry weather conditions of flow, when the weight of pressed screenings per 24 hours varied from 2,800 to 3,100 lbs. About 200 lbs. coal was required to start the fire at the beginning of each shift, or 0.2 lb. coal per lb. pressed screenings.

A similar press, but operated by both steam and hydraulic power, was installed at *Boston* at the Calf Pasture pumping station in 1912. This required the attention of but one man while handling one to four charges per hour. The dewatered material was burned without difficulty. The press here is understood to have proved satisfactory.

At the Ward Street pumping station a steam-operated press 24 in. x 18 in, diam. has more recently been installed. The screenings, dewatered to 65%-75%

*Paper before American Society for Municipal Improvements.

†Sanitary Engineer, Board of Estimate and Apportionment, New York City.

moisture, are burned under the boilers of the plant. A press of this kind, operated by steam or hydraulic power, will handle about 500 cu. ft. of wet screenings per day and cost in the neighborhood of $3,000.

In 1914 the city of *Baltimore* installed a 24 in. press similar to that at the Calf Pasture pumping station at Boston. Pressures here were carried as high as 170 lbs. per square inch. Four and one half baskets were charged per hour, requiring the attention of two men. In spite of the pressures used, the moisture in the product was too great for easy burning, possibly due to the high rate of operation.

In 1921 three more presses of the same type were installed at the main sewage pumping station. Four pressings per hour can be made with these if necessary. By measurement, about three cu. ft. of dewatered screenings were produced from each of 48 pressings per day from a sewage flow of 25 mg. As these weighed 60 lbs. per cu. ft., the total output amounted to about 8,000 lbs. per day. To burn this required about 1,600 lbs. of coal.

In 1926, C. E. Keefer made tests in pressing the screenings at the Eastern Avenue sewage pumping station.*

Average Results

	Unpressed Screenings	*Pressed Screenings*
Cubic feet per m. g. sewage	7.75	4.04
Pounds per cu. ft	60.17	50.03
Per cent moisture	86.45	72.19
Coal used for incineration: Lbs. per cu. ft. screenings	....	11.07
Per cent reduction in volume by pressing	....	47.85

*Proc. Am. Soc. C. E. Sept., 1929. The flow handled at this station averaged 25 m. g. d. in 1925.

The estimated cost of a pressing and incinerating plant to dispose of the screenings at this station was:

Building	$3,540
Press	3,600
Incinerator, chimney, etc	1,800
Total	$8,940

and the annual cost was:

Fixed charges		$894
Operation		
Coal (97 tons)	$626	
Power for press	10	
Removal of ashes	20	
		656
Total		$1,550

As a result of these tests it was decided to continue this method of disposal.

Dallas, Texas, installed a 19-in. hydraulic press in 1915. With a pressure of 60 lbs. per square inch, four to eight baskets of screenings were pressed per

TABLE I

Amount and Character of Fine Screenings

Location	Width of Opening	Screenings Per mg. Cu. ft.	Screenings Per mg. Lb.	Screenings Per cu. ft. Lb.	Moisture %	Volatile %
Brooklyn, N. Y., 26th Ward	5/64"	8.8	....	....	82	83
	1.16"	7.5	....	....	80	81
	3/64"	5.7	....	....	86.8	93.5
	1/32"	5.2	....	....	77	68
Los Angeles, Cal., N. Hyperion	1/16"	16.5	....	....	87	....
Long Beach, Cal	1/32"	27	1810	67	87	....
Remodeled	1/16"	....	2485	....	75.85	....
Milwaukee, Wis.	3/32"	7-8	515	....	86-90	....
Experimental	1/8"	21	985	47	88	....
Pasadena, Cal.	1/16"	30	....	....	88	....
Plainfield, N. J.	1/16"	15.8	....	....	89	....
	1/4"	5.67	261	46	84	....
New York, Dyckman St.	3/64"	27.1	1449	53.4	78	88
	1/16"	18.4	1040	56.5	82	91
New Britain, Conn.	1/16"	30	2020	67.3	81	....
Reading, Pa.	1/30"-1/36"	31	....	....	89.5	....
	.014"	25	1500	60	89.5	73
Brockton, Mass	.0214"	38	1990	52	71	....
Guildford, Eng.	.25"	9.3	370	40	75	....
Burton, Eng.	.38"	9.5	380	40	75	....
Bromberg, Poland	.08"	13.4	870	65	85	....
Leeds, England	.125"	36	1080	30	....	....
Leipzig, Germany	.31"	2	80	40	75	....
Columbus, Ohio	.375"	4.6	300	65	....	....
Croydon, England	.4"	14.6	583	40	75	....
Frankfort, Germany	0.4"	15.8	635	40	....	....
Elberfeld, Germany	0.4"	21.6	865	40	70	....
Göttingen, Germany	0.4"	14.7	337	23	83	....
Dresden, Germany	0.08"	26.2	....	....	84	....
Strassburg, France	0.10"	43	....	....	89.3	....
Trier, Germany	0.10"	8.6	....	....	55	....
Temesvar, Rumania	0.12"	35.1	....	....	65	....
Keansburg, N. J.	3/64"	44	....	60	....	....
Cleveland, Ohio	1/50"	....	858	....	94	73
Experimental	1/80"	....	674	....	90	64
	1/120"	....	682	....	86	72

TABLE II

Analyses of Screenings

	Brockton Mass. a	Hamburg Ger. b	Frankfort Ger. c	New York Dyckman St. d	Cleveland Experiments e		Milwaukee Wis. f
					Meshes per inch.		
	Centrifuged				50	80	
Moisture	71.54%	83%, 92.6% 85.2%	80%	68.2%	94%	80%	91.6%
Nitrogen	0.612%	.78%, .27% .02%	0.82%	2.25%	1.5%	1.3%	4.66%
Potash	0.1121%	....	0.40%	.064%	....	....	....
Phosphoric acid	0.115%	.42%, .18% .12%	1.57%	1.11%	0.6%	0.6%	....
Fats	....	7.88%, 1.68% 5.11%	....	21.1%	6.8%	6.3%	....
Organic (dry basis)	73% g	67+% g	87% g	73.8%	73%	64%	....
Ash	5.43%	1.33%, 1.10% 5.16%	....	26.2%	....	....	8.9%
Calorific value	9345 Btu	....	....	....	....	....	8600

a. Metcalf & Eddy, "American Sewerage Practice," III. 252.
b. K. Allen (Merkel), Trans. Am. Soc. C. E., LXXVIII, p. 895.
c. K. Allen (Tillmans), Trans. Am. Soc. C. E., LXXVIII, p. 1056.
d. K. Allen, Proc. A. S. M. I., 1921, p. 138.
e. Hoffman, Pratt, Hommon, Report Sewage Testing Station, 1914.
f. Public Works, Jan., 1929.
g. K. Allen, Proc. A. S. M. I., 1919, p. 179.

Analysis of Ash from Burned Screenings, Long Beach, Calif. SiO_2, 46.14%; K_2O, 2.85%; P_2O_5, 10.82%; Na_2O, 1.82%.

24 hours sufficiently to burn readily under a boiler. The only attention required was that of the boiler room helper. The operation of this press is said to have been satisfactory.

There has been little experience as yet in the dewatering of *fine* screenings. With the larger amount of fine organic material, their water content is probably given up somewhat less readily than from coarse screenings, but from what has already been accomplished and with the more extensive experience in dewatering sludge, the question of dewatering fine screenings may be considered a matter of detail.

Fine screenings have been dewatered for several years by pressing in the *Borough of Queens* at three plants in the vicinity of Flushing Bay. The screenings are then burned in small oil-burning "Incinerites." A test of one of these, located at Corona, was made in 1920. The screenings were placed in the hand press and left to drain for 19 hrs. when they were removed and burned. The 2.78 cu. ft. of pressed screenings contained 69% moisture, weighed 52.0 lbs. per cu. ft. and were consumed in 3 hrs. with a loss of 93% weight, for which 0.018 gal. of oil was required per lb. of dewatered screenings. By care in firing, these small installations are quite satisfactory.

Experiments in pressing screnings were made by C. E. Keefer at the Back River disposal plant, *Baltimore,* in 1927, using a cider-type press operated by steam under 175 lbs. per sq. in. pressure. The press was manufactured by the Coffin Valve Co. and cost, in 1919, $2,785. The screenings averaged 7.75 cu. ft. per mg. sewage and contained about 86% moisture, which was reduced to 72%, with a reduction of 48% in volume by the operation.

At *Milwaukee* it was attempted to press the fine screenings in a Berrigan press. This proved quite feasible but was finally abandoned as too costly.

A plant designed by Metcalf & Eddy is now being installed at *Dayton, Ohio,* in which the screenings from a Dorrco screen with ⅛-in. slots will be dewatered in presses made by the Hydraulic Press Mfg. Co. and then burned in a specially designed incinerator. It is estimated that the moisture content of fine screenings from 26 mgd. sewage will be reduced from 85% to 65% by placing them in slotted baskets and compressing under a hydraulic plunger. The 230 cu. ft. of dewatered material produced per day will then be burned together with screenings from a 4-in. rack 80% moisture and skimmings 75% moisture.

From the foregoing it is safe to conclude that normal screenings—whether from coarse or fine screens—may be dewatered in a press of proper design to such an extent as to be disposed of by burning, with little additional fuel, under boilers, in a garbage incinerator or in an incinerator specially designed for the purpose. At Baltimore the life of a press of the cider type has been found to be about eight years. These are generally of 24-in. or 26-in. diameter, operated under a pressure of 150 lbs. per sq. in., and compress the screenings to half their original volume.

Experience with wet screenings has not been so convincing, although these are burned in a few places.

At *Miami, Fla.,* about 40 cu. ft. per day of screenings, averaging 50 lbs. per cu. ft., are successfully disposed of by incineration in a Nye "Odorless" incinerator without additional fuel and without odor, after pressing under a dead weight of 500 lbs. They are stored in covered garbage cans until night, when they are hauled to the incinerator. This is located in a residential section.

The fine screenings at Rye, N. Y., and Long Beach, Calif., and coarse screenings at Canton, O., are disposed of without pressing; at Rye in an adjacent Morse Boulger incinerator with the village garbage, and at Long Beach and Canton in incinerators designed for the plant. At Long Beach 47.7 cu. ft. of screenings per day about 80% moisture are successfully burned in a dutch-oven furnace with 21,300 cu. ft. of natural gas. At Canton about 27 cu. ft. of screenings of similar water content are incinerated daily after an hour's draining in perforated cans, together with an average of about 5 dead animals, with the use of about 10 tons of coal a month. At the Jamaica Plant, Borough of Queens, the 5 cu. ft. of fine screenings per mg. from a flow of about 10 mgd.

of sewage contained 87% moisture. The attempt to dispose of these wet screenings with the city refuse in a 150-ton incinerator did not prove satisfactory.

CENTRIFUGING

There is no reason to suppose that screenings as well as sludge may not be dewatered by centrifuging. The smaller volume of foul drainage liquor would present a less serious problem and it is quite possible that a less expensive type of centrifuge than the Besco ter-Meer might answer the purpose. Very little has been attempted in this line but as the number of screening installations increases it is possible that this method of dewatering may be found practicable.

At *Reading*, Pa., screenings from a fine-mesh "Weand" screen were placed in canvas bags and dewatered by a centrifugal "hydro-extractor," about 6 ft. diam. x 3½ ft. high, which reduced the moisture in a charge of 500 lbs. from 85-90% to 61-73% moisture in 8 minutes. Its weight was reduced from 65-70 lbs. to 30-35 lbs. per cu. ft. by the process, when it contained about 72% volatile matter. It was then burned under the boiler at the plant. The plant was rebuilt some years ago and the screen abandoned.

Experiments were conducted by George B. Gascoigne at *Cleveland* in which about 1¼ tons of fine screenings, 85% moisture, after a brief period of draining, were placed in burlap bags and dewatered in a "Laundryette" centrifuge. The moisture was reduced to 65% and screenings burned in a small "Kewanee" incinerator by adding about 25% of coal by weight. The incinerator had a nominal capacity of 300 lbs. screenings per hr., 90% moisture. Some smoke and odor were given off, but no complaints were recorded.

Screenings were burned under a "Sims" boiler for a while at the Easterly Works several years ago after dewatering in a "Troy" centrifuge but some odor resulted and the practice has been given up.

Centrifuges, belt-driven or direct-connected, are on the market that may prove adapted to service of this nature. They generally consist of a perforated basket 30″ to 40″ in diameter in which the screenings are placed and which rotates at speeds as high as 900 rpm., the drainage liquor being let off by a pipe. To unload, the basket is raised, moved to one side and dumped by rotation on trunnions. In one type there is a counter-balanced "unloader" which, by a slow rotation, scrapes the cake gradually from the top down. The material thus loosened falls through a port in the center of the bottom, provided with a cone valve, to a conveyor or truck.

The first cost of a 40″ centrifuge is about the same as that of a press. Operation is largely automatic, requiring but one man, but a fair comparison with presses, which have more often been used, cannot be made at this time.

CONCLUSIONS

Dewatering screenings to an extent when they may be burned without difficulty may be accomplished by pressing, and probably by centrifuging. With the increasing number of screening plants and a growing insistence on hygienic conditions, this method for their final disposal seems likely to develop in the future.

In conclusion, the author desires to acknowledge as the source of much valuable information that he has freely drawn upon in the preparation of this paper, the following gentlemen: Major D. A. Davison, U.S.A., and Messrs. Robert Cramer, George B. Gascoigne, Charles C. Hommon, J. E. Jewett, F. B. Jones, C. E. Keefer, W. T. Knowlton, F. A. Marston, Langdon Pearse, Asa E. Philips, W. M. Piatt, Harry L. Shaner, Ralph Van Duyne and W. W. Young. Thanks are also due the several manufacturers of dewatering machinery and incinerators for details concerning their devices that have been kindly furnished.

Note: The application of devices for filtering or straining slimes or sludges has not been discussed in this paper, for although some of them may prove valuable for the dewatering of screenings, reliable information as to results obtained has not yet been made available.

Approved Water Supply Signs

The Kansas State Board of Health furnishes at cost signs similar to that shown in the illustration to those cities whose public water supplies meet the bacteriological requirements of the United States Public Health Service for water used on interstate carriers. These requirements are quite strict as regards the presence of B. coli organisms and a great many supplies, particularly ground water supplies, do not meet these requirements. In order that signs be erected, the laboratory record must show that not more than 10 per cent of all ten cubic centimeter portions of tap water examined show the presence of B. coli and that not more than 5 per cent of the sample shall show B. coli in the 10cc portions.

Two hundred and twenty of these signs had been purchased up to a few weeks ago.

What Are the Fundamental Requirements of a Modern City?

What Do YOU Think?

Some time ago the editors of Public Works were asked by a national organization to prepare an outline of the fundamental requirements for a modern city. Herewith is given, in substance, our reply. It presents in brief form the factors that appear to us as essential *to fullest development, prosperity, health and happiness of those who go to make up a city. Many others are desirable, such as shade trees on residence streets, public comfort stations, libraries.*

Comment is invited. Tell us what YOU think a modern city should provide for its citizens.

The Editors.

UPON the physical environment of the dwellers in any community depend to a very large extent the health, morals, and, therefore, the happiness of the individuals, and the prosperity of the community as a whole. The chief benefit of community life in organized cities is that cooperative effort, utilizing the foresight and ability of the governmental authorities, can secure for each individual far greater environmental advantages than would be obtainable by individual action. Progress in civilization consists largely in broadening the field of these advantages, offering more of them to a larger percentage of the population. In fact, the extent of these physical environmental advantages in a given city or country is a commonly accepted measure of its civilization. Below is given a resume of some of the more important items that are instrumental in bettering modern community life. Arrangement of subject matter is not made in accordance with any assumed relative importance of the several items.

Paving and Street Design:—Roadways should be adequate in width, and the surface should be impervious, dustless and of the proper type to carry the traffic expected for that street: and sidewalks should be of ample width to carry safely all pedestrian traffic. Corners should have safe radii for turning. Streets should be provided with adequate name and direction signs, and the houses numbered. Maintenance of streets should be under the direction of an experienced engineer.

Water Supply:—The source and quality of the water supply should be of a character approved by the state board of health. The quantity should be sufficient to supply peak demands, including the fire protection recommended by the Board of Fire Underwriters. Distribution of this water should be to all homes; the pressure should be adequate to reach to the top floors of all buildings (except tall office buildings, which may be cared for otherwise). There should be a competent superintendent in full charge of the system, and the purification plant, if there is one, should be under the personal direction of an operator licensed by the State Board of Health and under its general supervision.

Sewerage: — Sewers should be provided to all homes physically possible of access, and places not possible to reach with sewers should be served with individual or group septic tanks or sewer systems. Such sewage treatment should be provided as is necessary to produce an effluent harmless and unobjectionable to other communities. Storm drainage should be provided adequate to carry off all ordinary rainfalls, and subsurface drainage constructed where necessary to eliminate swamps and wet areas and prevent damp cellars.

Refuse Disposal:—There should be prompt, frequent and cleanly collection of garbage, and satisfactory disposal, preferably by incineration. The use of proper containers at homes, and of sanitary and odorless collection equipment by the municipality, are important. For rubbish and ashes, also, there should be ample facilities for cleanly collection and proper disposal. Prompt and sanitary removal of trade wastes is important.

Street Cleaning:—Roadways and sidewalks should be cleaned in a sanitary manner, with modern equipment and at sufficiently short intervals to keep them always clean, and the sweepings disposed of without offense to any one. Snow should be so handled as to minimize interference with wheel and pedestrian traffic.

Street Lighting:—Adequate lighting is necessary to insure safety of traffic and pedestrians on all streets. The design and character of the lighting units should harmonize with local conditions.

City Plan:—A continuous commission to prepare and keep up to date a plan, with provision for growth, development of new areas, annexations, etc. Zoning of the city, under the direction of experts; enforcement of zoning and planning regulations without favoritism.

Traffic and Transportation:—Ample provisions for carrying citizens between their homes and the business and shopping districts quickly and easily. Facilities, such as marginal railroads in the larger cities, docks, etc., to insure ample and cheap flow of foodstuffs into the city. Proper routing of traffic to avoid congestion. Adequate and suitable traffic control. Provision for parking, and for loading and unloading trucks, without blocking traffic or endangering pedestrians.

Housing and Building:—The elimination of slums; approved building regulations to insure modern and healthful structures; the regulation of rooming and boarding houses and hotels; the regulation of stables and of the maintenance of animals within the city limits.

Park and Recreation Facilities:—Ample park area, with facilities for recreation for adults and children.

In the larger cities, a trained park and playground supervisor.

Airports:—An adequate airport, located within a reasonable distance of the city center, with hard-surface roads leading to it.

Schools:—Buildings to provide seating capacity and full-time attendance for all children, well lighted and ventilated, fireproof, convenient and safe of access, with adjacent playgrounds. An adequate school nursing and health service.

Health:—Adequate regulations, backed by trained inspection service, governing the production and handling of milk, meat and food products, and the operation of restaurants and other food purveying establishments. Provision for communicable disease control; mosquito and fly control; the prevention of nuisances; clinics; vital statistics; and community hospital.

Smoke Control:—Restrictions as to the use of soft coal and educational and regulatory work in regard to the firing of furnaces and power plants to eliminate unnecessary smoke.

Fire Protection:—The provision of modern apparatus located properly to give maximum protection to all parts of the city; the housing of apparatus and firemen in appropriate structures. A complete and modern fire alarm system. The necessary laws and regulations, backed by efficient inspection, to reduce fire hazard.

Operation of These Facilities:—The mere physical presence of these facilities is of little value without skilled and authoritative agencies for operation. A trained, intelligent, interested and conscientious health officer, city engineer, water works superintendent, superintendent of schools and of parks and recreation facilities, chiefs of fire and of police, all are necessary to insure maximum benefit to the people from such facilities. Selection of such officials should be based on training and ability, and the tenure of office should not be affected by political changes.

Dustless Ash Removal

One of the great nuisances connected with ordinary methods of collecting and removing ashes in American municipalities is the dust caused by dumping the ashes into carts on windy days. This nuisance can be avoided in a number of ways, one of which would be to remove the ash barrel with its contents, replacing it with an empty barrel as is done in some cities in collecting garbage. This and other methods have not been practiced, chiefly because of the expense involved. But with the increasing demands of the American public for greater comfort and convenience in connection with municipal housekeeping, it is probably that this will be remedied before many years.

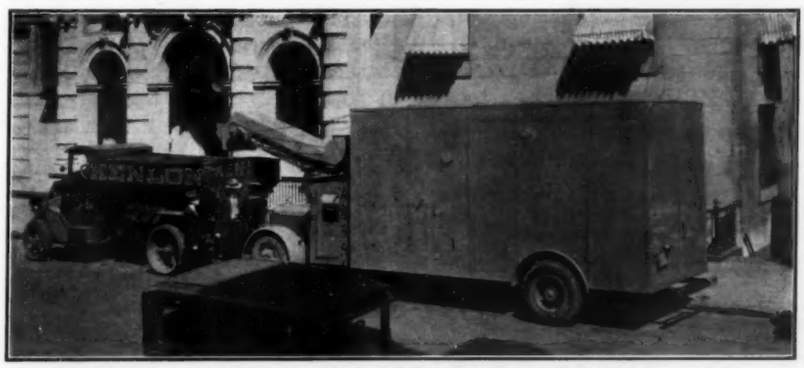
PNEUMATIC ASH-CONVEYOR TRUCK CONNECTED TO CELLAR PIPE

Enclosed conveyor belt seen at the right

In New York City a method of avoiding ash dust has recently been tried out and put into service by a local company, using an equipment constructed especially for this purpose. This equipment consists of a truck containing a hopper into which the ashes are drawn by suction through a large tube; the hopper being inside of a large enclosed truck. The ashes in the hopper are then conveyed by a totally enclosed conveyor and discharged into an ordinary open truck, which is spotted just in front of the pneumatic truck and which carries the ashes to their destination.

The enclosed truck is equipped with a gas-electric drive, which furnishes power for operating the suction system and also the conveyor belt, as well as propelling the truck itself. The suction is created by a centrifugal compressor rated at 6000 cu. ft. per minute at a speed of 3500 revolutions per minute and driven by a 40 h.p. motor. The capacity of the equipment is a suction of 2800 cu. ft per minute, giving a velocity of 145 ft. per second in the intake pipe.

A permanent pipe line is installed in the building extending from the ash bin to the sidewalk, and the truck makes connection to this pipe by means of a pipe section attached to the truck and connected to the hopper, which section is lowered into place and tightly connected at the sidewalk with the permanent line. This equipment is designed for apartment houses and other large buildings, but it is proposed later to construct a smaller unit with a flexible pipe line which can be used for removing ashes from the cellars of residences without having to incur the expense of a permanently installed pipe line and vault under the sidewalk.



PNEUMATIC ASH CONVEYOR DISCHARGING ASHES BY ENCLOSED CONVEYOR BELT INTO ORDINARY TRUCK FOR REMOVAL

AT LEFT, ORD FINISHER. CENTER, MULTI-FOOTE MIXER

Use of Local Stone and Sand on a Concrete Highway Job

Stone quarried within three miles of the job and sand secured from bank near one end of same. Equipment used in quarrying, crushing, screening and hauling aggregate

A section of concrete highway is being constructed between Chester and Florida, N. Y., by the Lane Construction Corporation, Meriden, Conn. A point of interest on this job, aside from the characteristic Lane thoroughness and care, is the use of local stone and sand for aggregate.

The work involves the construction of 4.33 miles of two-lane, 18-foot concrete highway. The thickness is 8 inches at the edges and 7 inches in the center; standard mesh reinforcement is used; the mix is 1:2:3½. About 60,000 cubic yards of excavation was required, of which about 15,000 cubic yards was rock. On this work, Ingersoll-Rand equipment was used on rock, and the spoil, both rock and earth, was handled with a pair of Bucyrus-Erie 1-yard shovels, one of which was a gas+air. The material was handled into rented motor trucks for hauling to points of fill.

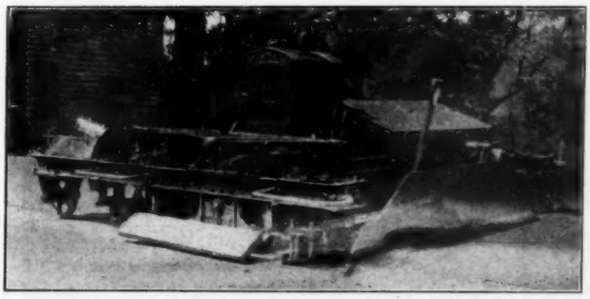
The fine grading gang, which operated normally two or three hundred yards ahead of the mixer, was composed of 4 men equipped with a 5-ton Buffalo-Springfield roller with pneumatic scarifier. Just ahead of this gang was the form-setting gang, also composed of 4 men. Metaforms were used.

BUFFALO-SPRINGFIELD ROLLER AND FINE-GRADING GANG AHEAD OF MIXER

A Multi-Foote 27E mixer was used, mixing 8-bag batches. The normal mixing and finishing crew comprised about 13 men, as follows: 1 cement man, 2 reinforcement and joint men, 5 spaders and spreaders, 3 men on the finishing machine; 1 broomer, 1 on final finish, and 1 operator. The mixer worked away from the supply point, and turning of the loaded trucks was not necessary; but a turning point for the empty trucks was provided about 100 yards ahead of the mixer, giving ample space for one or two, or even more, loaded trucks to wait their turn to deliver to the mixer. An Ord finisher was used on this job. Servicised expansion joints were placed at intervals of 78.5 feet.

Pneumatic tires were used exclusively on the trucks, and allowed use of the finished subgrade by the loaded truck without damage. International, G. M. C., Mack and Brockway trucks were used, being hired from local sources. Each truck carried two 8-bag batches composed of 8 sacks of Whitehall cement, 16 feet of sand and 28 feet of broken stone.

Burlap was used to protect the freshly laid concrete, with hay for final curing. The road was opened to traffic in 15 days. Water was secured by damming a small stream about mid-



ORD FINISHER AT WORK

INTERNATIONAL TRUCK DUMPING BATCH INTO MIXER

way of the job, and pumping the water with a Barnes pump, powered with a LeRoi engine, through a 2-inch pipe line equipped with outlets at 300-foot intervals.

No traffic control is maintained, since there is room at many points for traffic to pass. Stone is quarried about two or three miles from the job and hauled in motor trucks to a stock pile near the Florida railroad station, where it is dumped, and loaded into a Johnson batching bin with an Erie steam crane equipped with a ¾-yard Erie clamshell. Sand is secured from a pit near Chester, where it is screened and is then hauled by trucks to the stock-pile and handled in the same manner as the coarse aggregate. The trucks hauling sand and stone are of the same general type as those hauling the batches to the mixer, and are hired locally. They are available for use on either type of work, thereby adding to the flexibility of the organization.

The quarry is well located for economical procurement of the stone. It is high up on a hillside, and the crusher is placed some three or four hundred feet below, so that the loaded motor trucks, which are used to transfer the stone from the quarry to the crusher, have an all-downhill haul. Drilling at the quarry is performed with Ingersoll-Rand equipment, powered by an Ingersoll-Rand and a Sullivan truck-mounted air compressor. DuPont dynamite is used for blasting, and the rock is handled by a Bucyrus-Erie ¾-yard steam shovel into Mack and Sterling 5-ton motor trucks, which are equipped with Wood hoists and bodies. Pieces too large for the crusher are mud-capped and broken down so as not to exceed 12 inches in size. Two trucks, under the conditions existing, are ample to handle from the quarrry to the crusher the stone required for the entire job.

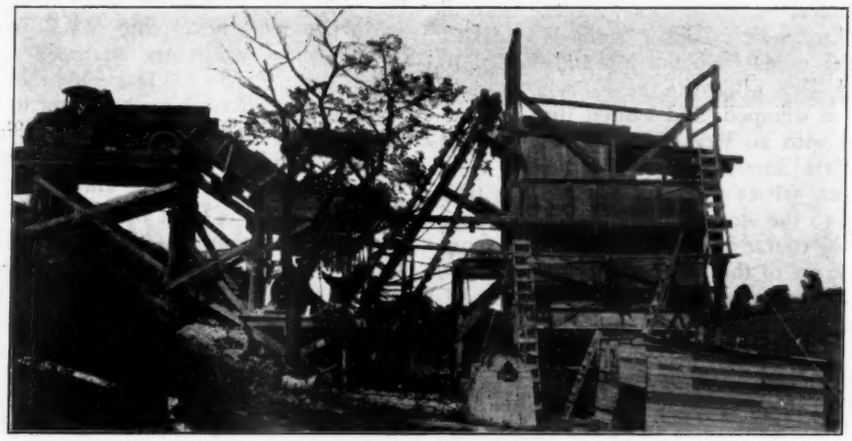
The crusher is built on a hillside so as to allow a minimum of raising of the stone, and to provide easy facilities for loading the trucks which are used to haul the material to the stock pile. The outfit includes a No. 11 Acme crusher as the main unit; stone too large to meet specifications are taken out and carried by a belt conveyor to a smaller Climax crusher mounted alongside. The whole outfit is powered with a Waukesha industrial power unit type JLL. Water for the quarry and crusher equipment is provided from a small pond by a Goulds pump working against a head of about 300 feet.

The sand screening plant at the bank in Chester is home-made from materials at hand, and is operated by a Velie automobile engine. Material is fed to the

STOCK PILE AND BIN, WITH ERIE CRANE FILLING SAME FROM STOCK PILE. INTERNATIONAL TRUCK LOADING

THE QUARRY. ERIE STEAM SHOVEL LOADING A MACK TRUCK

SAND PIT, SCREENING PLANT AND BINS AT CHESTER



THE CRUSHING PLANT. MACK TRUCK AT LEFT READY TO DUMP LOAD

bucket conveyor by a dragline arrangement using a Sauerman Crescent scraper operated by a Twin-Disc Clutch hoist, powered with a Waukesha VL unit. The coarser materials, not available for use on the road job, are sold locally.

Among the hauling contractors are F. S. George & Son, Inc., of Stottville, N. Y., with Macks; Keener Bros., Port Jervis, N. Y., and A. H. Fahs, Stottville, with Brockways. C. Way is the superintendent for the Lane Construction Corporation, with C. Goodell as assistant.

Sewage Disposal at California Training Camp

Of the two chief end products of sewage treatment processes, sludge and effluent, many engineers have succeeded in persuading farmers to use the sludge, but few, especially of those in the east, expect them to use the effluent. This, however, has been done in disposing of the sewage at the National Guard training camp at San Luis Obispo, Calif. In this camp, which accommodates about 5000 men, the sewage is collected by about four miles of vitrified 6″ and 8″ sewer pipe, which delivers the sewage into an Imhoff tank approximately 50 ft. long, 16 ft. wide and 22 ft. deep. The digested sludge from this tank is drawn off onto a sludge bed. The effluent is pumped by an electrically driven pump through 4700 ft. of 6-in. welded steel pipe to a storage reservoir on a neighboring farm.

Traffic on Interstate Bridge and Tunnel

The Holland Tunnel carries vehicular traffic between New Jersey and New York City, and the Philadelphia-Camden bridge carries such traffic between New Jersey and Philadelphia. Both have been completed about two years, and a comparison of the traffic carried by each during 1928 is interesting. Such a comparison has been sent to us by P. K. Schuyler, president of the Federal Bridge Co., as follows:

	Philadelphia-Camden Bridge		Holland Tunnel	
	No. of Vehicles	Percent of Total	No. of Vehicles	Percent of Total
January	581,945	5.99%	553,805	6.33%
February	555,696	5.71%	537,498	6.15%
March	657,294	6.76%	601,831	6.88%
April	728,163	7.49%	697,255	7.97%
May	829,841	8.53%	755,923	8.64%
June	871,082	8.95%	783,778	8.96%
July	1,063,159	10.93%	843,593	9.65%
August	1,044,579	10.74%	822,926	9.42%
September	942,270	9.69%	827,879	9.47%
October	881,472	9.06%	809,439	9.26%
November	790,455	8.13%	749,319	8.57%
December	779,514	8.02%	761,428	8.70%
	9,725,470	100%	8,744,674	100%

The heavy traffic over the bridge in July and August is attributed to summer traffic for the New Jersey coast resorts. In each case the total is much greater than had been anticipated. At both places ferries carry the traffic—mostly trucks—that does not use the bridge or tunnel. There is a toll of 25 cents for using the bridge and 50 cents for the tunnel. The difference in toll rate is probably part of the cause of the greater popularity of the bridge.

The Future of Garbage Collection and Disposal

By Carl Schneider*

At the eighth conference of the International Association of Street Sanitation Officials, Carl Schneider, chairman of the committee on methods and costs of garbage disposal systems, presented a report which concluded with a series of queries. These were not discussed at that time, but at the conference last month Mr. Schneider discussed them at some length in a paper entitled "What Does the Future Hold for Garbage Collection and Disposal?" In this he does not attempt predictions or recommendations, but expresses some of his personal ideas. The paper is given below:

The questions with which the committee concluded its report at the eighth conference were as follows:

WHAT ABOUT THE FUTURE?

Just think these questions over:

Will the demands of taxpayers for *service* and *sanitation* be any less than heretofore?

Is it to be expected that the American garbage cans will continue to contain sufficient food values to feed half the heathen races?

Does not the strife for luxuries become greater and the anxiety for necessities diminish as the years go by?

Are we not headed for mass production methods for feeding the poor and similar sociological problems? (Witness the numerous city Community Chests to blanket the budgets of all charitable institutions.)

Is it "right" or "fair" for government to compete with industry in pork, stock feed, grease or fertilizer and then tax the industry to pay the losses of the city-managed business?

These are all put as questions which are intended to be self-answering. This discussion, however, should not stop at simply answering "yes" or "no" to the questions. We should look a little further and see the economic picture which they suggest. "The world is ever moving forward toward higher standards of living. The luxuries of yesterday are the necessities of today. We don't care a damn for the necessities of life, we crave for the superfluities." We have heard such statements so often that their repetition sounds like parrot-talk. It is not for us to deny such statements or to try to escape from them; it is for us to get in line and adapt ourselves to them. So, I say that the signs of the times indicate the importance, yes, the necessity, of raising the standard of the garbage service.

One thought that is suggested by these questions is that the garbage of the future does not promise to be as rich as in the past—not so much from the desire of the American to eat less or waste less food, but more or account of his desire for "superfluities" A sandwich answers for a meal so that gas can be bought for the car. The desire to save time and spare effort is responsible for many a meal being prepared at factories and served from tin cans. The consumption of canned foodstuffs and the kinds of foods prepared in such form are constantly increasing. Little waste goes to the garbage pail from such foods. Again, the increasing use of ice and electrical refrigeration tend toward greater utilization of food values at the dining table and less waste for the garbage pail. One does not need to search very far nor long to find ample evidence that these conditions are going to become more important to consider in planning for the future.

It has been my experience that whenever I start to discuss the subject of garbage disposal with a layman not well-informed on the subject, he immediately wants to know what profits will be derived from the disposal scheme. Somewhere back in the past he heard of some city that was making money from garbage "by-products"—his city ought to do the same. This idea is not limited to a few individuals, it is indeed widespread. I am not going into a discussion as to what arguments should be used against the spread of such an idea. Close examination of the report will reveal them. I feel, however, that the fundamental argument should be that it is not the *duty* of a city to its taxpayers to make profits out of any of its municipal functions, nor even its privilege to compete with its taxpayers or dependents in any line of business. When such an undertaking is brought home close to the taxpayer, he is quick to take in the situation and demand its suppression. I call to mind an occasion when the city of New Orleans undertook the job of paving at cost a driveway on private property of a church. The paving contractors were soon at the City Hall protesting against the city's taking work in competition with them. The job was finished by contractors.

I feel that the competition is just as unfair even if the one whose business is hurt by the city is not a resident taxpayer of it. The prosperity of the Iowa farmer is just as important to the city of Chicago as is that of the bricklayer resident of the city. The farmer buys washing machines, radios, furniture and other manufactured articles on whose production and sale the prosperity of the citizens of Chicago depends. Why, then, should Chicago hurt her customers by producing pork or grease from garbage in competition with the Iowa farmer's corn-fed pork? If the country were threatened with serious shortages of the products that can be produced from garbage, their recovery would be not only justifiable but even highly commendable. Such is not the case. We are not always at war; and a search of statistics will readily show that our peace-time productions capacity in prac-

* Aide to the commissioner of public property, New Orleans, La.

tically every line of business is far above our normal consumption rate. Garbage is waste, and as such should be gotten rid of in a sanitary and economical manner. The quest for profits from garbage by-products is usually chimerical. Big business in competitive lines will manage to keep it so.

What then is the duty of the city to its taxpayers? Thinking in terms of the four parts of the system, viz., house treatment, collection, transportation and disposal, the duty of the city is to perform and co-relate these functions so that the system will be sanitary, give excellent service and be as economical as local conditions will permit. We should not be content with a system that is merely expedient. It is not my purpose to advocate or condemn any particular system of collection or disposal. I merely am trying to state fundamental requirements.

To this association it should not be necessary to say that any system used should be sanitary in every respect. Here is a little thought, however, that I would like to leave with you. Sanitation is derived from the Latin word "sanitas," meaning "health." All that any of us can hope to secure during his life may be summed up in the single word "Happiness." Even Schopenhauer, the morbid philosopher, says that true happiness without health is impossible—"a healthy beggar is happier than an ailing king." Draw what philosophical conclusion you will from these statements, to me they emphasize the importance of sanitation to a degree insurmountable by any other factor.

In the case of service, we shouldn't think that this factor has been fully satisfied when we collect the householder's garbage regularly and punctually, and in doing so have not wrecked his garbage can. We must put dignity into the service—raise the standard. I often think of the remarks of a college professor made at a technical society meeting—something on this order: "We have always looked on the handling of garbage as a swill-man's job because nobody but a swill-man was wiling to fool with it." This attitude, I believe, is still only too prevalent, due to the lack of dignity, class, or elevation of standard in the garbage service of our cities. In elevating the standard of the service, every branch of it must come in for study: the equipment, the shops, the disposal facilities, the methods and order of work. Think of the advertising value alone of well kept equipment, and the message it tells of efficient government. Let the taxpayer point out the city's equipment to the visitor with pride, not with shame. Once the city has set its house in order and established a high standard of service, the householder will quickly lend his co-operation to further improve the service. Let us not be too zealous in arresting the householder for "violating the garbage ordinance" until the city's part of the work is done in a manner unassailable.

As for economy, it should never take precedence over sanitation and rarely over service. Even a few frills and foibles are at times justifiable extravagances. I do not mean, however, to condone wastefulness. If a job is capable of being done by two men, three men should not be employed to do it. Every part of the service should receive the full benefit of the administrative brains and engineering talent available to keep the cost down. Taxes are high, let us admit. But every tax increase is usually the result of the taxpayers's demands for more or better service. I don't think that the taxpayer can expect to have his taxes reduced through reduction of the garbage expenditures. He needs better service, whether he admits it or not, and will have to pay the cost of it.

There is just one more thought that I want to express before concluding. I think it is the most important thing I have to say, and I wish that I could express the idea with the full emphasis it deserves. To steal some of Senator Pat Harrison's thunder "Let me stamp it on your hearts, let me burn it into your minds!" Whether or not you strive for higher standards of service in equipment or facilities of one kind or another, give some honest-to-goodness thought to the welfare of the rank and file employees—the important cogs of the machinery. Let not the uppermost thought be "how much work can be gotten out of a man?" Under proper management and treatment, you will be surprised at the amount of work that will be put forth without forcible extraction. His job should be as safe and sanitary as possible. Help him to learn the "one best way" to do each part of his work. Provide him with proper tools and facilities. Seek cooperative service from him—build up an *esprit de corps*. Imagine yourself in his place and don't forget the golden rule.

You will probably think that I am concluding a sermon, and to keep you in that frame of mind I am going to provide you with a text.

I am going to refer to the report of Proceedings of the Seventh Annual Conference of this association which was held in St. Louis, January 10th and 11th, 1927. The following remarks were made by our good, lamented friend, Ed. Murphy, of Boston:

"* * * I think that we officials of the United States lose sight of the fact that it is a sanitary measure to remove the household rubbish and garbage and it should be done in a sanitary manner.

"Mr. Galligan spoke this afternoon of the introduction of flower boxes to the congested districts of Chicago. One of our richest suburbs, the town of Lockhan, which is the richest suburb in Massachusetts, sends around a white truck, immaculate, painted right up to the minute, with four men, two on each side. The men have galvanized iron buckets, go into the garbage sheds, remove the garbage, and place it in this beautifully painted truck covered with a tarpaulin or canvas which is washed every day. It is really giving a little tone to the collection of garbage. I think we all lose sight of that fact.

"'Our mayor said to me the other day, 'When you collect a man's garbage and ashes in a nice cleanly manner, you don't tip over his barrels and you make the woman of the house and the maid of the house feel pretty well. The next time I run for office they will all say, "Well, this fellow did something." ' So I think the dollars and cents can be lost sight of when we give service to a municipality. * * *"

Those remarks of Ed. Murphy's have stuck with me ever since I heard them. I only hope that I am echoing his message to you. Remember that immaculate, white truck of Lockhan. Plan right and go ahead; I believe the taxpayer will meet you more than half way.

Widening Curves on California State Highways

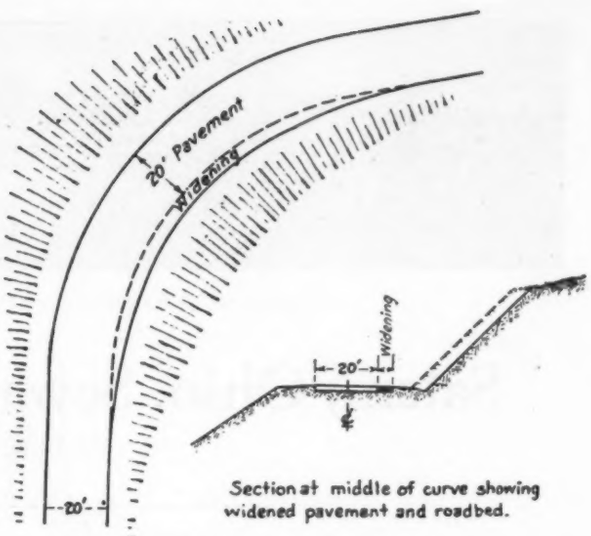
Policies Adopted to Facilitate Safe Travel for Present-Day Traffic at Higher Speeds.

The Division of Highways of the California Department of Public Works has recently adopted the policy of widening the pavement and roadbed on all curves having radii of less than 500 feet. The widening, which is applied to the inside of the curves, varies from a minimum of two feet for curves of 400-foot radius or greater to a maximum of four feet for curves of 200-foot radius or less. The transition from normal unwidened roadway to fully widened roadway is made in a distance of approximately 80 feet. In every case the pavement edges follow mathematically precise curves which insure pleasing appearance and are easy to lay out.

The widening policy has been adopted in line with the best modern highway engineering practice in an effort to build into California roads the maximum degree of safety, ease and riding efficiency. Curve widening is being practiced in various forms by a number of highway organizations, usually, however, in connection with sharper curves and narrower roadbeds than are used on modern state highways. With the general adoption of the 10-foot width for single traffic lanes, 20-foot width for two-lane pavements, wide shoulders, moderate speed limits, and definite restrictions of vehicle dimensions, curve widening seemed unnecessary. In the last year or two, however, speed limits throughout the country have undergone decided upward revision in response to popular demand.

A properly aligned and superelevated curve produces, at reasonable safe speeds, little or no steering effort or swerving sensation. A passenger riding with eyes closed should be practically unable to distinguish between straight and curved road. Various driving tests indicate that on properly superelevated curves of about 1000-foot radius or more, a car can be guided safely without appreciable effort at any practical speed within a 10-foot traffic lane. On curves of from 500-to 1000-foot radius the steering effort and sensation of curving become appreciable, and speed restriction is often necessary on the shorter radii if the driver is not familiar with the road. On curves of less than about 500-foot radius, speed restriction is necessary and there is a definite lurching effect at high speeds due to the sudden change from straight to curved progress. A too sudden change from a straight to a curved path is productive of accidents. The change in direction should be accomplished gradually to avoid the lurching and weaving tendencies. It is to assist in this easier change of direction and to eliminate as much as is economically possible the hazard which the sharp curve presents, that the widening of roadbed and pavement is introduced.

Standard widening as applied to California highway curves modifies or overcomes the tendencies encountered on the sharp curves within practical limits and provides greater safety ease in the following ways:



PLAN AND SECTION OF WIDENING OF PAVEMENT AND ROAD BED AT CURVES ON CALIFORNIA ROADS.

1. Sight distance is increased, which adds to safety.

2. With the aid of a traffic stripe 10 feet from and parallel to the inside edge of the pavement, traffic in both lanes is directed along a path which corresponds closely to a parabolic transition between straight line and curve. The approximate length of 80 feet for the widening transition was selected carefully with a view to securing a combination of the most natural, convenient, and economical transition for average, reasonable, practical speeds. Safety and driving ease are thereby increased.

3. In case a car traveling at excessive speed does lurch, additional passing room is provided on the outside of the curve, toward which the car will swerve. The additional width allows more room for maneuvering the car and so adds safety.

4. Greater clearance, with increased safety and beneficial psychological effect, is provided between passing vehicles of unusual width.

The actual design of the widening is based on a careful study of modern contemporary practice and represents the best efforts of the engineers of the California Division of Highways to incorporate into their highway designs the maximum of safety and service for present and future automotive traffic, with due regard for the high speeds which almost surely will prevail in the future.—*From "California Highways and Public Works," official journal of the Dept. of Public Works.*

Los Angeles is to build another dam to take the place of the St. Francis dam which failed last year. It will create a reservoir of 36,000 acre-feet capacity near the existing Chatsworth reservoir. This location was recommended by A. J. Wiley, of Boise, Ida., and Louis C. Hill of Los Angeles (vice-president of the Am. Soc. of Civil Engineers), consulting engineers employed by the Department of Water and Power of Los Angeles, after an examination of a number of locations. Since the going out of the St. Francis dam the city has suffered for storage capacity and work on the reservoir will be begun as soon as possible.

OLD SEWAGE TREATMENT PLANT OF SALEM, OHIO, IN JULY, 1928.

Salem, Ohio, Sewage Treatment Plant

By F. S. Barckhoff*

This plant is probably the most up-to-date one yet constructed. (Claims of contenders for this title, with descriptions of plants, will be welcomed and published.) The grit removal channel is aerated as is the influent channel. Double provision is made for removing grease and burning it. Excess storm flow is treated on sand filters. Primary or pre-clarification and secondary clarification with mechanical concentration are followed by tertiary sedimentation, and this by chlorination. Sludge is digested, and resulting gas used for heating digester, operating gas incinerator (for burning screenings) and laboratory use. Four methods are provided for disposing of excess activated sludge. Digested sludge is dried on filters.

All sewage, water, sludge, gas and electricity are metered at several places. Pumps, blowers, and clarifiers are controlled by push buttons in the main building, which contains chemical and biological laboratories.

In the spring of 1927, the city of Salem, O., which has a population of 11,000, was in possession of a sewage treatment plant, consisting of three plain sedimentation tanks, a dosing tank and ten intermittent sand filters. This plant, which was constructed in 1912, was far too small to cope with the increasing sewage flow. Thirty-three lawsuits had been filed by riparian owners for the period of 1925 and 1926 alone.

Salem is situated at the top of a divide with no streams available for dilution of sewage, and it became necessary to design a plant which would render complete control of the sewage.

Surveys revealed a dry-weather flow of 400,000 to 950,000 g.p.d., with 200 p.p.m. suspended solids; a wet-weather flow of from one to six million gallons per day, and no industrial waste.

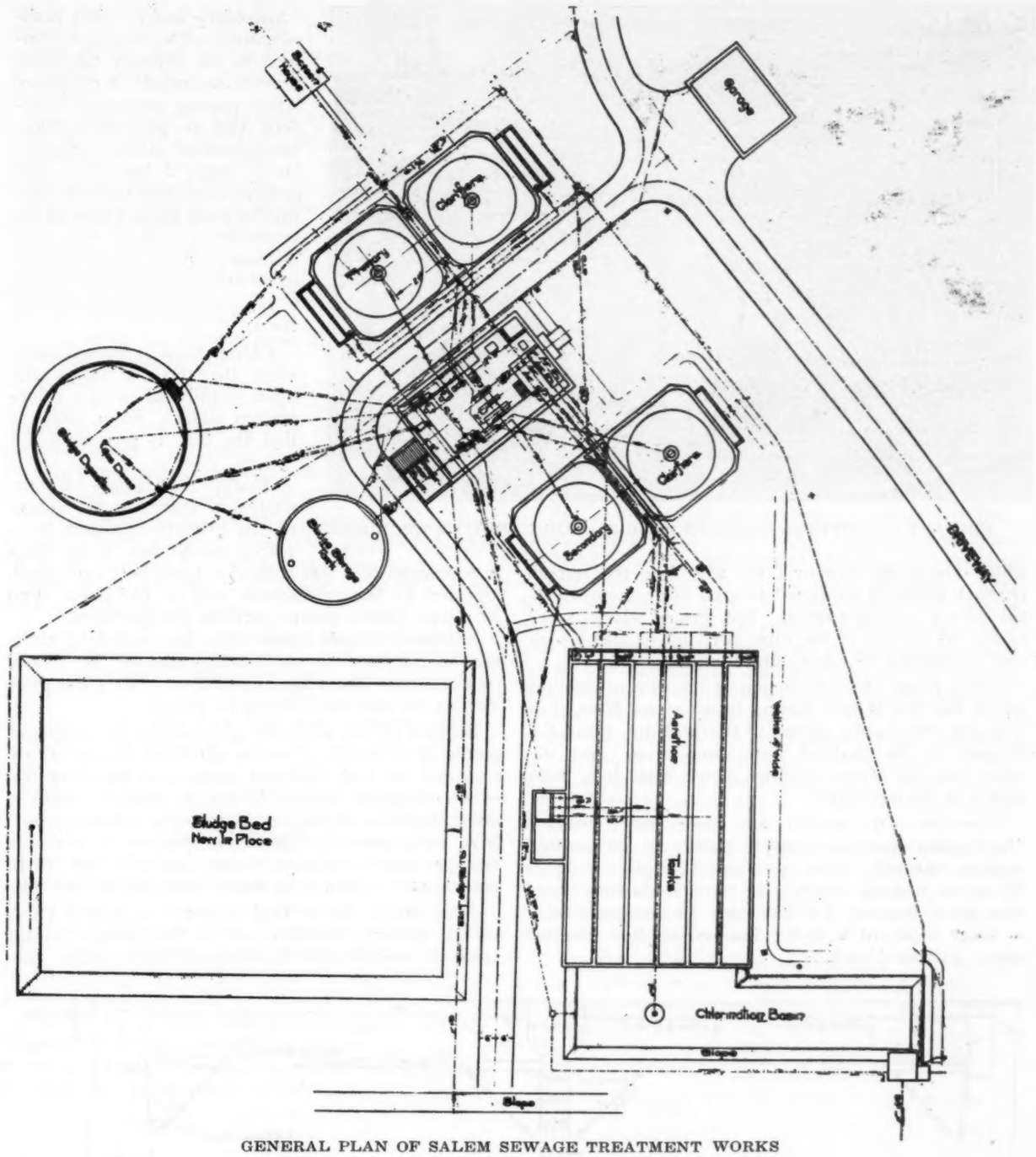
* City engineer of Salem, Ohio.

After estimates had been made covering three different types of plants, we prepared plans for a separate sludge digestion and gas collection type of plant, with activated sludge for secondary treatment, for 15,000 people. In the fall of 1927 the voters approved, by a vote of three to one, a bond issue for $195,000 for constructing such a plant, and eight contracts were let July 10th, 1928. The plant contracted for is described below:

Screens—Two screens consisting of one mechanically operated Dorr bar screen with 1¼" openings; one manually operated emergency screen located in a by-pass channel with 1½" openings. One six-bushel capacity Buffalo Co-operative Stove Company gas incinerator.

Grit removal is accomplished in an aerated influent channel to the primary clarifiers. Filtros plates are placed along the bottom of the influent channel,

SALEM'S NEW PLANT, JULY 9, 1929.
From right to left: Screen building, digester just behind it; primary clarifiers; main control building; secondary clarifiers and aerators; garage, chlorination building in the background.

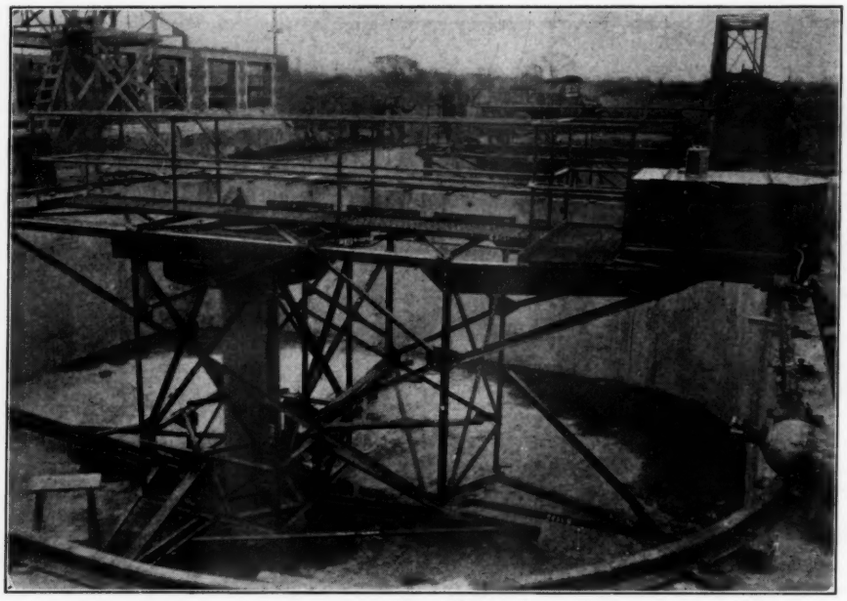


GENERAL PLAN OF SALEM SEWAGE TREATMENT WORKS

which is 22 feet 6 inches long and 3 feet wide. One to two cubic inches of air per minute per lineal foot of channel keeps the organic matter in suspension and allows grit to settle over the plates. The grit removal is accomplished by periodically opening a sluice gate provided at the end of the channel, the grit being conducted hydraulically to a sand filter to dry.

Clarifiers—Sewage flow passes over weirs from the influent channel to two 35-foot Dorr traction-type clarifiers with a side water depth of 8 feet. Detention varies from 30 minutes during peak flows to 3 hours during minimum flows.

Grease Removal—Influent and effluent scum boards provide for catching grease. Grease removal is accomplished in two ways. All grease retarded in front of the influent scum boards is drawn off through a drop valve and conducted into an adjoining wet well and from there to sand filters. The effluent scum boards are removable, and when the top sections are removed, the grease which has collected behind them moves forward with the normal sewage flow over weirs into a double effluent channel. This consists of two channels parallel to the effluent weirs. The first channel is connected to the piping leading to the aeration tanks and is separated from the second channel by a 22-foot weir. When grease is to be removed, a plug valve is closed in the outlet of the first channel.



PRIMARY CLARIFIERS, SHOWING DORR SLUDGE HANDLING EQUIPMENT

which forces the flow over the weir into the second channel, which is connected to sand filters onto which the grease is thus carried. The grease which is retained on the top of the filter curls up in thin layers and is removed by raking and then burned.

Storm Flow—By adjustment of the effluent channel weirs, the flow is split during heavy storm flows, 2 to 3 m.g.d. rate being passed to the aerators, while the balance of the clarified storm flow passes over the weirs into the second channel, which leads it to sand filters of the old plant.

Aeration—The normal flow passes from primary clarification through Venturi meters to an aerated mixing channel, where activated sludge is added. From the mixing channel the flow passes over weirs into three aerators, 200 feet long, 10 feet wide, with a water depth of 9 feet. The normal flow receives about six hours' aeration.

Secondary and Tertiary Sedimentation—Two clarifiers, identical to the primary clarifiers, provide secondary clarification. After passing secondary clarifiers, there are provided tertiary sedimentation tanks, rectangular in shape, 3 feet deep, with bottoms sloping to one end, having the same surface area as the secondary clarifiers. Cleaning of these clarifiers is accomplished by flushing to the sand filters or pumping to the primary clarifiers.

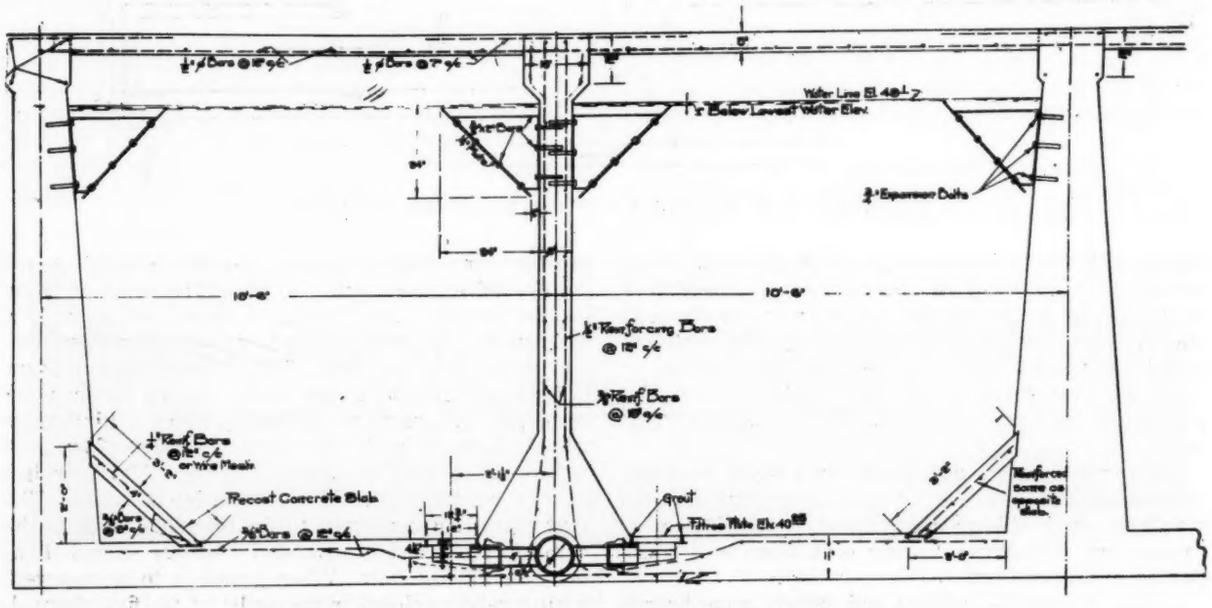
Chlorination — Immediately after the tertiary tanks, the plant is provided with a chlorination station. From this station the flow is passed to the stream.

Sludge Handling—Primary sludge is drawn to the center of the primary clarifiers by a raking mechanism. From there it is pumped to a gas collection type, heat controlled, digester, 50 feet in diameter and 20 feet deep. Two 50 g.p.m. Dorrco pumps perform the operation.

Activated slugde taken from the secondary clarifiers is returned to the mixing channel by Woods trash pumps. There are available one 150 g.p.m., one 200 g.p.m. and one 350 g.p.m. pumps.

Because of the difficulty encountered by numerous plants in disposing of excess activated sludge, Salem provided for four different methods of handling this excess activated sludge. It may be pumped direct to sand filters for drying, or returned to primary clarifiers, or pumped to digester, or pumped to a sludge storage tank to settle, a storage tank 35 feet in diameter and 11 feet deep being provided for this use.

Supernatant liquor from digester is passed either to the primary clarifiers or to the sludge storage tank, for resettling. Supernatant from sludge stor-



CROSS-SECTION OF TWO OF THE SIX AERATION TANKS.

age is conducted to sand filters, to aerators or primary clarifiers. Digested sludge from either digester or sludge storage is conducted to sand filter.

Gas Utilization — Gas collected from the digester is piped to a drip pot, then to a meter, then to a water-sealed blow-off chamber. Excess gas is diffused at a point above the roof of the main building. Some of the gas is utilized to operate a gas incinerator and for laboratory use, but the majority enters a Bryant gas hot water boiler.

A hot-water heating coil encircles the digester and by means of it a temperature of approximately 75 to 80 degrees is maintained in the sludge. Also hot-water heating is provided in the main building from the gas-fired boiler. In addition, there is provided a coal-fired hot-water boiler for emergency use.

MECHANICALLY OPERATED SCREEN AND GAS INCINERATOR.

Blowers—Three Connersville positive displacement blowers of 500, 750 and 1000 c.f.m. capacity furnish air to the aerators and aerated channels at 4½ to 5 pounds pressure. The blowers are rated at a maximum of 6 pounds pressure.

Plant Control—The control of the entire plant is centered in the main building. All pumps, blowers and clarifiers are operated by push buttons arranged on a Westinghouse switch board. Current is received at the plant at 2300 volts, and three transformers are arranged with taps for 110, 220 and 400-volt currents.

Venturi meters are provided for measuring main sewage flow, the air of each aerator, and return activated sludge. Metering is provided for electrical current consumed on each blower, for lighting, and a demand meter is arranged to register demand on the entire plant or to provide readings on any unit.

A water meter records the amount of water circulated to the digester. A gas meter (which is recording an average of 11,000 c.f.d. from the digester) is of the type adaptable to a recording head.

Bypasses have been arranged throughout the entire plant, making it possible to cut out any unit or the entire plant. Through the system of by-passes, the plant can be operated without primary clarifiers activating the entire sewage flow, in the same manner that the Milwaukee plant is operated.

The buildings consist of garage, screen building, digester building, chlorination housing, and main building. Office, laboratories, pumps, blowers and meters are all housed in the main building. This latter building is built in three floors; the bottom level, 16 feet below the ground elevation, acts as a pipe gallery; the second level, 9 feet below grade, houses the pumps and blowers; and the top level is occupied by an office, chemical laboratory, biological laboratory and meter space.

Operating Results—Averaging the results obtained, as given in the report for August of this year, we find a pH. value of 7 for raw sewage, with a slight rise of alkalinity in the plant and a pH. in the final effluent of 7.5.

The settleable solids in the raw sewage varied between 5 and 7 c.c. per liter; the primary effluent showed a reduction of from 73% to 100%, with a detention averaging three hours; and the final effluent showed a constant removal of 100%.

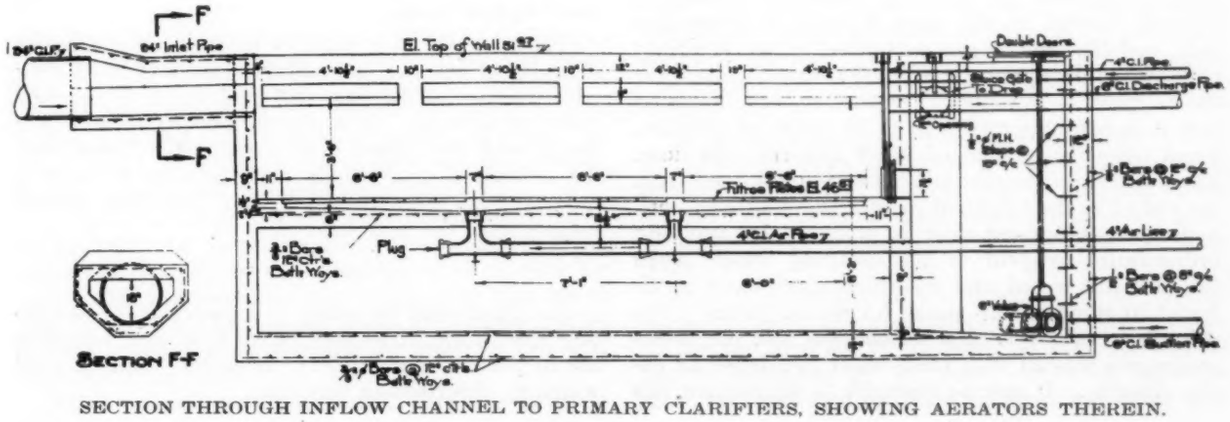
Suspended solids in the raw sewage, 176 to 420 p.p.m.; in final effluent, 90% to 96% reduction.

Ammonia reduced from 15 p.p.m. to 5 p.p.m.

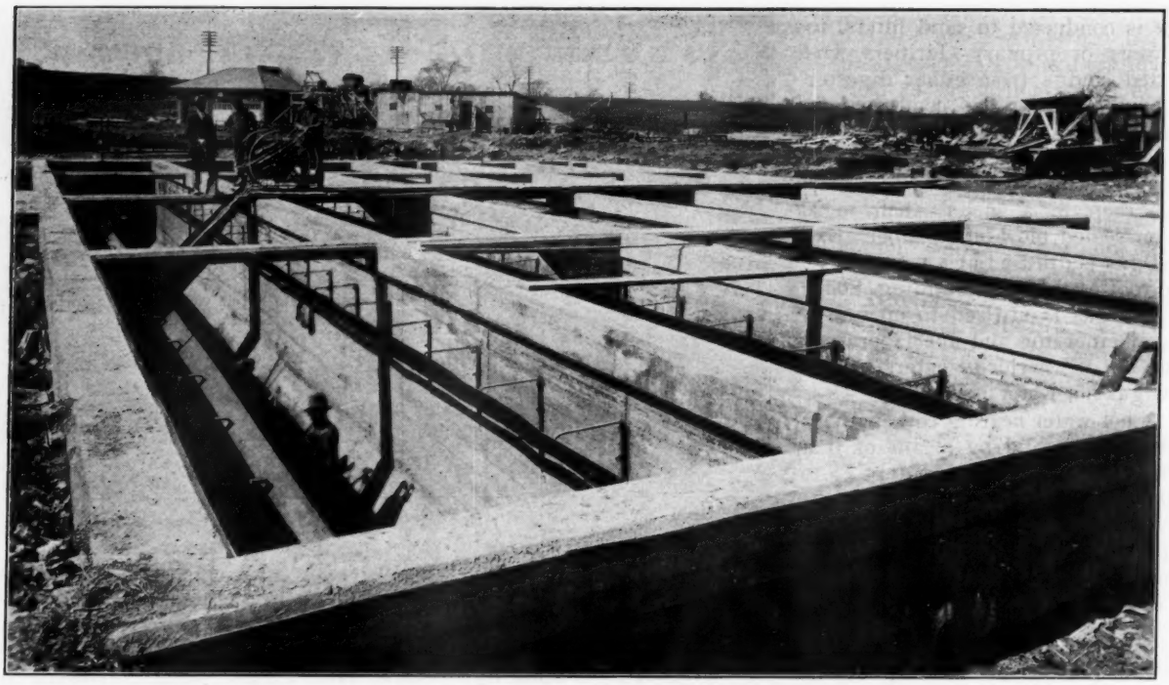
Nitrites average 1 p.p.m.; nitrates, 2 to 4 p.p.m.

B.O.D. varied in raw sewage from 125 to 250; reduced 92% to 95% in the final effluent.

The average flow for this month was one m.g.d.



SECTION THROUGH INFLOW CHANNEL TO PRIMARY CLARIFIERS, SHOWING AERATORS THEREIN.



AERATORS DURING CONSTRUCTION.
Sewage being aerated can be seen in the middle tank

Treatment of the city's sewage, consisting of primary sedimentation and filtration, was uninterrupted during the entire construction. This new plant was entirely completed in less than a year by the contractor, Freeman & Jones, Inc., of Cleveland, Ohio.

R. P. Vickers is the chemist of the plant and C. C. Hommon consulting chemist in design. The writer was designing engineer.

Sterilizing New Water Mains

In an address before the Texas Water Works Short School, E. C. Sullivan, of the U. S. Public Health Service, stressed the probability that water mains will be polluted, sometimes seriously, while being laid and the resulting desirability of thoroughly flushing them before use, or better still of sterilizing them.

For the latter, either calcium hypochlorite or liquid chlorine may be used. In using liquid chlorine, a tank of chlorine gas may be connected through a diffuser inserted in the main through a corporation cock, and the flow of gas controlled by the auxiliary tank valve; or equipment specially manufactured for the purpose is available. Experience has indicated that it is desirable to use 10 to 20 p.p.m. of chlorine, based upon the amount of water receiving the dose. The dosed water is allowed to flow through, and from the end of it, the length of main being sterilized until a decided orange-red color is produced by applying orthotolidine reagent to the escaping water, when the outlet is closed and the chlorinated water is allowed to stand in the mains for several hours. The chlorinated water is then flushed out and the mains thoroughly flushed with fresh water to remove all excess chlorine. It may be desirable to supplement this treatment by bacteriological examination of samples of water collected from several points along the new main, as is the practice in Chicago.

New York City requires the contractor to place in each length of pipe, as it is laid, a half-ounce of chloride of lime, or to place on each side of each gate valve on the line an amount equivalent to a half-ounce for each pipe between it and a point midway to the next valve.

Wisconsin Adopts New Traffic Code

Six tons more weight will be allowed six-wheel trucks than four-wheel trucks in Wisconsin on Class A highways. On a Class B highway a six-wheeler is allowed to weigh 19,000 pounds or two tons more than a four-wheeler.

The new code, which will go into effect soon, also limits the load per axle. No vehicle shall be operated on any Class A highway when the gross weight carried by wheels of any axle exceeds 19,000 pounds, or upon a Class B highway when such gross weight exceeds 12,000 pounds.

Operators of heavy vehicles in Wisconsin who had difficulty in carrying a profitable load and complying with the law in the past will find relief in the new traffic regulations. It is also interesting to note that trucks with their loads more equally distributed over the front and rear wheels, will be able to carry a heavier load than trucks having the load carried largely over the rear axle.

Are Americans becoming "air-conscious"? Contractors at least are, if we may judge from their extensive use of pneumatic machinery; as on the Mohawk Trail widening described in this issue.

Roadside Beautifying in Massachusetts

Considered a part of highway maintenance. State nursery and central station at Palmer, from which several parties operate, planting trees and shrubbery. Some principles as to selection of trees and of locations for them, methods of planting, and selective clearing of roadside vegetation.

In 1912 the Massachusetts Highway Commission assigned to one of its employees the duty of planting trees along the state highways, and during the next few years many thousand shade trees were planted. In 1921 an office was created to be filled by one with special training in landscape planning, whose duty was to "beautify the state highway roadsides," and roadside planting is now considered as a phase of highway maintenance and is under the supervision of the engineer in charge of state highway maintenance. It is supported financially by an allotment for this specific purpose, and is entirely separate from tree work, brush cutting, grass mowing, etc.

The hope is ultimately to make each of the seven highway districts a unit of itself in the matter of tree and roadside care; but at present the work is carried on from a base in the centrally located town of Palmer, where there are 12 acres of nursery, seed beds, propagation frames, greenhouse, storage cellar, forge, shed for housing and storing machinery, explosives and other necessary materials. A state nursery is considered necessary as a propagating area, for planting collected stock and growing them until fit for the roadside; also for studying characteristics of plants and their adaptability to the roadsides of the state.

It has been found that trees 10 to 12 feet high are the most desirable size for planting, while shrubs should be 3 to 4 feet high and vines should be three to four years old. Planting material before then is found to be a waste of money. Plantings are confined in the main to rights of way having at least 60 feet width, and in every case it is the rule to plant as near the property line as possible to allow for future widening of the roadway.

The planting procedure is as follows: The designer at the Palmer station, using a blue print showing the location of the road and right-of-way lines, indicates on it the proposed planting. The locations of the various plants and trees are then staked out and pits for them dynamited or otherwise excavated; tree pits 3 feet in diameter and 3 feet deep, and shrub pits 2 feet in diameter and 2 feet deep. Where necessary, the holes are filled with the best loam obtainable. The trees and shrubs required, an order for which has been given to the nursery, are delivered to the assigned places by trucks and trailers.

A space three feet in diameter around each plant is grubbed and kept free from weeds, and watered if necessary. Up to this point the work is done by one of three crews, each consisting of a tree agent and three men. Two of the crews are equipped with a camp wagon—a small house on wheels which will comfortably house the four men.

After a planting has been well started it is given a final inspection and turned over to the district maintenance force for care.

The commission is trying to produce a highway hybrid—a cross between a surface expert, a tree surgeon and a landscape designer. It is educating a small army of men whose primary interest is in the road surface, whose natural attention is to lines and grades, pot holes and breaks, tar barrels and side drains, to take an interest in vines, shrubs, trees and the artistic utilization of them along the roadside.

It aims to follow the advice of Prof. Chas. S. Sargent, director of the Arnold Arboretum: "Avoid the artificial; keep the roadsides as natural as possible." In cities and villages, formal planting of trees is necessary; but along highways the planting of long stretches of evenly spaced and straight-lined trees and shrubs is avoided as suggesting artificiality, unnaturalness. Even continuity of shade for mile after mile is considered to be depressingly monotonous, however welcome a mile or two of it may be after a sunny stretch of road.

Native trees and shrubs are used, as being accustomed to the state's soil and climate and therefore more hardy, and especially as representing the state's personality. There is an abundance of them—ferns, vines, bushes and trees—at all times, from the shadbush in spring to the autumn leaves of the witch hazel.

Tree surgery is considered important. Trees wounded by automobiles have the scars trimmed and sealed with durable tree paint. Any decay found in a tree is removed, and if the area is in a rigid part of the tree and is not too large it is filled with a mortar of clean, coarse sand and cement mixed one to three and as dry as practicable, tamped thoroughly to fill the entire space and smoothed up to the inner edge of the cambium. In the case of a large opening, where a crack might form around the edge of the mortar when it sets, the mortar is filled to within an inch of the surface and allowed to set, and the remaining inch is filled with a mixture of asphalt and sand, just warm enough to be plastic, tamped firmly into place. If the wound is in limbs subject to bends and twists, cement mortar is not used but the entire space is filled with a mixture of asphalt and sand or sawdust.

Splits are often repaired by drawing the parts back into contact (before any decay sets in), using a metal rod or cable to hold them so, and calking the edges of the split. Galvanized eyebolts and cables are used, ¾-in. to ⅞-in. eyebolts and ⅝ in. to ¾-in. wire cable.

Dead trees are cut off six inches below the surface of the ground. For large trees a power saw is used.

Care is taken not to cut down all roadside vegetation indiscriminately, for some cannot be made to grow by transplanting, like the mountain elder and

the tupelo, and it is very difficult to transplant the elderberry although it grows profusely when planted by nature. Others difficult to transplant are the sassafras, tulip, canoe birch, and cedar. Sumac, benzoin, the viburnums, the cornels, American plums, laurel and many others are looked out for and encouraged to grow along the roadside. Grape vines, however, throttle shrubs and are rooted out. Ferns, including the sweet fern, also are spared.

There must, of course, be exceptions for practical reasons. At curves and corners, vegetation must often be removed or confined to the lowest plants to give better vision.

A state law requires that all trimming of trees to give clearance for telegraph and other wires be done under the supervision of an inspector from the state's roadside planting organization, the expense of which is paid by the public service company. A better solution, secured in some cases, is the substituting of a single cable on 25-foot poles for a number of wires suspended from cross-arms on 50-foot poles.

Trees and other beautiful vegetation are sometimes removed for a short stretch to afford a view of distant mountains or valleys or near-by streams. Half a day with three or four axmen in Agawam unveiled a splendid view of the Connecticut river. A few hours with an ax on a curve revealed a beautiful picture of distant hills and a winding stream. But each of these was preceded by long and painstaking study to be sure that the right trees were removed and the least possible number of these.

At places which suggested their suitability for the purpose, clearings along the roadside have been made where a tire can be changed or the car parked while lunch is eaten. Natural springs have been developed by digging a small depression and walling with small stone; or by carrying the water through a birch bark trough.

For covering bare banks in cuts or fills, grape vines, woodbine, wild clematis, and Hall's honeysuckle are used; the last makes the quickest ground cover. Unless the soil is good, the bank is covered with at least two inches of loam, saved from the surface when excavation was begun. Red clover on an inch of loam has given satisfaction. Daisy seed sown on seemingly hopeless slopes has given surprising results. On sandy soils, as on Cape Cod, the bearberry furnishes a distinctly beautiful ground cover.

For side slopes in deep cuts, where the soil contains no humus, transplanted pines have been found most suitable. As they do not root deep, they are kept cut back to prevent their falling down the slopes.

Triangular islands at road intersections are covered with loam to a foot above the surrounding surface, bordered with a curb of stones and planted with low shrubs such as Japanese yew and juniper of the spreading type—euonymus radicans, hydrangeas arborescens, Tom Thumb, and globe arborvitae. When these have been planted, the remaining space is seeded with Kentucky blue grass and red fescue grass mixed 3 to 1 and rolled, and the grass kept mowed.

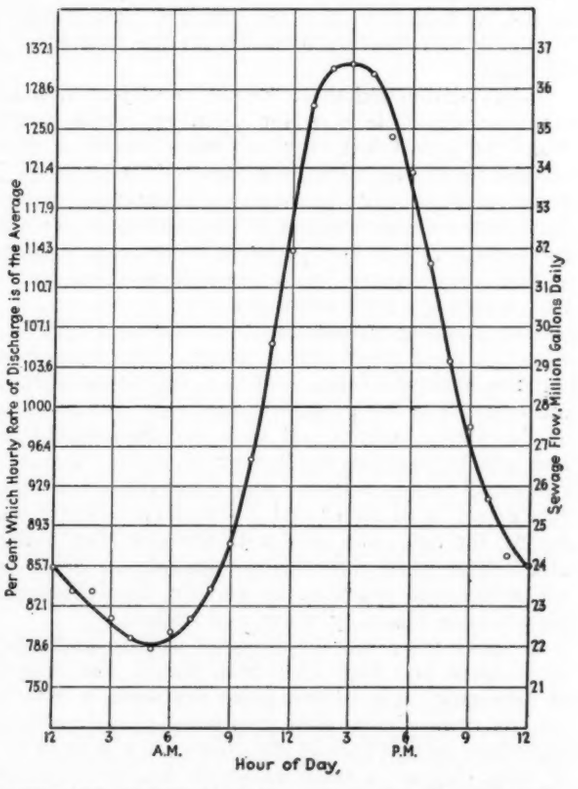
An effort is made to see that the roadside is kept neat; that a broken guard fence is mended at once; that cut brush is removed or burned immediately; that broken or disfigured road signs are repaired, repainted or replaced. The highway landscape supervisor, James H. Taylor, says: "The most important thing in roadside development is the provision for a permanent program. Lacking that means a waste of public funds.

"Everything finally resolves itself into maintenance. Roadside development should be begun at once; it never can be finished. I feel very deeply that what the roadside needs most is not that improvement be begun merely, but that it be continued; that a fixity of purpose be indelibly grained into the movement, to the extent of a state or national consideration that shall appreciate its importance; underwrite its future.

"Roadside improvement must not rest upon the enthusiasm of one man, who, dropping out of the picture takes the vitality of the moment with him. A kind of apostolic succession must be operative in order that the rank be kept filled, so that the business of roadside beautification may maintain a program as steady and sure as that of the surface which it borders."

California to Use 20,000 Gallons of Paint on Roads

Twenty thousand gallons of white paint will be utilized by the state of California in trying to keep automobile drivers on the right side of the road and prevent accidents on curves by means of white traffic lines. The state is planning to spend approximately $30,000 on 1,400 miles of roads. About fifteen gallons of mixture is required for each mile of road stripe.



AVERAGE HOURLY RATE OF FLOW OF BALTIMORE'S SEWAGE AT PUMPING STATION ON OUTSKIRTS OF BUSINESS AND INDUSTRIAL CENTER.

Reconstructing the Mohawk Trail With Bituminous Macadam

Methods employed in reconstructing road over Hoosac mountains, designed for modern high-speed traffic. Non-skid surface is provided by omitting seal coat. Large stone used in wearing course. Details of construction.

Construction work on the Mohawk Trail is going on between Charlemont, about 20 miles west of Greenfield, Mass., and the summit of the Hoosac mountains. Over this section of about nine miles, 6¼ miles is being reconstructed and paved, and 2¾ miles is being resurfaced. Throughout, the road is being constructed of bituminous macadam, 24 feet wide, with minimum grades and maximum radius curves consistent with the exceedingly rough terrain through which the road passes.

As laid out and authorized by the State of Massachusetts in 1911, the Mohawk Trail extends from Greenfield along the Deerfield and Cold rivers, over the Hoosac mountains to North Adams, a distance of about 38 miles. The original road, while not designed to attract motor traffic, became popular, and in 1927 construction work was again under way to provide facilities for carrying this traffic. Because of the mountainous character of the country through which it leads, sharp curves and heavy grades were common. In the work now under way, while the grades could not be materially changed, the curves were flattened as much as possible. On the section east of the summit, the maximum grade is 7½ per cent; west of the summit, where the famous Hair-Pin Turn is located, the maximum grade is 7 per cent. The work on the western section has recently been completed by the Lane Construction Corp., of Meriden, Conn. The work on the eastern side of the mountain is being done by D'Onfro Bros. Inc., of Leominster, Mass. It is expected that this will be completed by about November 1.

THE MOHAWK TRAIL

The D'Onfro contract involves the removal of 60,320 cubic yards of excavation, of which 27,670 yards is earth and 32,650 is rock. Embankment totalled 51,400 cubic yards, of which 21,800 yards was rock; and 14,525 cubic yards of borrow was required. In addition, the contract called for the construction of 3000 cubic yards of rough rubble toe walls; the building of 135 drainage structures; and the construction of 9 miles of bituminous macadam road, requiring the placing of more than 40,000 tons of broken stone and the application of 370,000 gallons of asphaltic material. The contract price was $451,700.

Machinery was moved onto the job the early part of March, 1929, but late snows and stormy weather delayed the beginning of effective work. Favorable weather during June, July, August and September permitted rapid headway, and on September 18 the work was 87.5 per cent completed, with the time but 79.4 per cent elapsed.

EXCAVATION AND GRADING

Rock Excavation.—On some parts of the work, notably in the section just west of the Cold River bridge, the rock excavation was very heavy. The contractor had on the job seven Ingersoll-Rand portable 110-foot air compressors mounted on Ford trucks, and a Sullivan steam compressor from which eight drills were operated. The drills were all S-49 Jackhamers. Two Ingersoll-Rand No. 34 sharpeners were used, and a No. 25 oil furnace. A portable blacksmith shop, mounted with a compressor on a trailer chassis, was a feature.

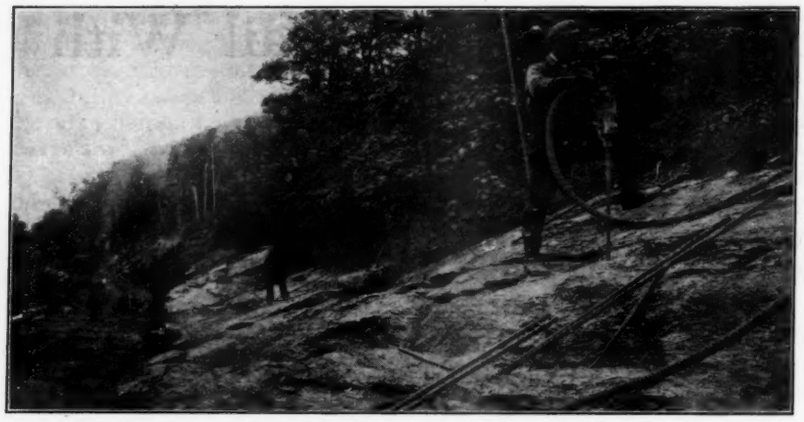
Night work was necessary on parts of the job because of the concentration of a large amount of work within a small area. For a time, drilling was carried on until midnight under the illumination of floodlights.

DuPont dynamite was used for shooting the rock, and during the busy season an average of 5000 pounds per week was used.

Rock pieces too large for easy handling by the shovels or to be handled by the trucks were drilled and shot again.

Earth Excavation.—Standard methods of earth excavation were followed throughout.

Handling Spoil.—On the job were three Bucyrus-Erie steam shovels, each with ¾-yard buckets; one Bucyrus-Erie gas+air with a 1¼ yard bucket; and one Speeder half-yard shovel. These loaded into motor trucks for haul to fills. The number of motor trucks varied at different periods, running as high as 38, but in the later stages of the job averaging about 25. These were 3½ and 5-ton, mainly Mack, Dodge and Schacht "Roadbuilders." All were equipped with Firestone pneumatic tires, this being practically necessitated by hauling conditions on the job, for the trucks were used also for hauling stone



ROCK WORK ON LANE COSTRUCTION CORP. CONTRACT. R-12 JACK-HAMERS

for the surface, and solid tires were found to cut and injure the subgrade and the partially finished roadbed.

CULVERTS

Cast-iron culverts made by Dan Dimick (the American Casting Company) of Birmingham, Ala., and concrete pipe culverts were used, the latter being employed principally for the larger culverts. At first, it was attempted to trench out the large culverts and lay the pipe by hand, but this did not prove very successful, and a Universal truck crane was hired and used on the larger sizes—30 to 60-inch. This cut out the culvert trenches very speedily, and placed the pipe also; doing the work at a cost much below that of hand labor, and also saving much time. In one case it handled successfully a 48-inch concrete pipe culvert, laid deep under the roadbed, with the lower end 30 to 35 feet down a steep slope.

PAVEMENT CONSTRUCTION

The Foundation.—The method of constructing the pavement, which has a total thickness of from 12 to 16 inches, is as follows: After the subgrade has been brought to the proper grade and shape, soft spots filled and unsuitable base materials removed, a foundation course is put in place. This, on the mountain section, consists of field or ledge stone, placed in a layer 8 to 12 inches thick. The stones composing this foundation course are not permitted to exceed 12 inches in their longest dimension, nor be less than 1½ inches in their smallest dimension; approximately one-half of the stone is required to exceed, in the longest dimension, one-half of the depth of the course. After being placed, this course is rolled with a 10 to 12-ton roller; sledges are used to break up the larger or projecting stones; or if not breakable or if they exceed in extent more than two-thirds of the distance from the bottom to the top of the course, they are removed and the space filled with smaller stones. After rolling, the course is filled with a clean, sandy gravel, which is rolled and broomed into the interstices, the surplus being removed.

On the section east of Cold river gravel is used for the foundation course. This is spread uniformly, with the larger stones generally on the bottom, but with no segregation of fine and large particles, to a depth of 8 to 12 inches, in two or more layers, and then rolled.

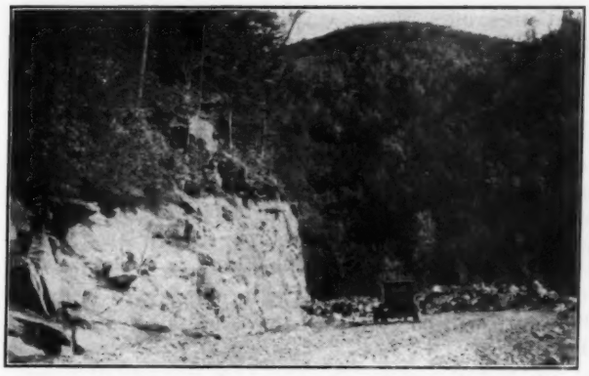
The material for the gravel course is obtained from borrow pits along the road, being taken out with power shovels and hauled to the road in motor trucks and dumped on the subgrade. At first a power grader was used for leveling the material, but the large stones within the gravel interfered with the operation of the grader. Hand labor was then tried, and was found to be probably the best method or removing the larger stones which were included in the gravel. These were piled alongside the road for future use in toe and retaining wall construction. The use of the Speeder shovel was found to be the most economical method of leveling these piles and getting the course to approximate grade.

The use of this foundation course is important in that it provides a firm base of known quality, improves the drainage of the subgrade and eliminates damage from frost boils and subgrade upheavals.

Base Course.—On this foundation course is placed the base course, which is composed of No. 1 (1¼ to 2½-inch) and No. 2 (¾ to 1¼-inch) stone. The stone for this course is required to have a French coefficient of wear of not less than 10, and a toughness of not less than 8. Where the gravel foundation course is used, the base course is 3½ inches thick when compacted, and where the stone foundation is used, the compacted thickness is 2 inches.

FIVE PORTABLE COMPRESSORS AND S-49 JACK-HAMERS ON D'ONFRO BROS. CONTRACT

ERIE STEAM SHOVEL LOADING INTO MACK TRUCK.



ROCK CUT AT TURN JUST ABOVE COLD RIVER BRIDGE.

WHERE SECTION OF LEDGE WAS REMOVED AT HAIRPIN TURN.

This course is spread from trucks hauling and dumping into a Galion sand and gravel spreader. This spreads only 8 feet in width, and since the road is being built in two sections, each 12 feet wide, further spreading is necessary. This is accomplished by using a Russell Junior blade grader drawn by two horses, which spreads out the stone layer. Final spreading is by hand, the men using stone forks.

After this layer has been brought to proper shape and grade, it is rolled, and a sand binder or filler applied.

Wearing Course.—The wearing course consists of No. 1 stone, laid to a compacted thickness of 2½ inches. It is spread by the same methods as are used in placing the base course, but even greater care is taken in order to obtain a uniform and smooth-riding surface. For this stone, a French coefficient of wear of 14 and a toughness of not less than 12 is required. This layer is rolled thoroughly.

It will be noted that this process of construction, with the larger stone in the wearing or top course, practically reverses the old-time methods of macadam construction.

Bituminous Materials.—Standard Oil Co. asphalt binders B and C are used on this job. The former, which has a penetration of 100 to 120, has been used since September 1; and the latter, with a penetration of 85 to 100 was used prior to September 1.

This material is shipped to the contractor's siding at the east end of the job in tank cars. The asphalt is heated in the cars by a small stationary boiler located at the siding, and is taken from the cars at 250 to 300 degrees F, and pumped into a special booster outfit mounted on a Mack truck chassis where it is heated to about 350 degrees F. It is then pumped into insulated tank distributors to be hauled to the job. Further heating in the distributors is not needed; application to the road is at about 330 degrees F.

Three distributors were used on the job, one Etnyre and two Merrill, mounted on Mack trucks. The maximum application in any one day was 12,000 gallons with an average haul of about 8 miles.

Application.—On the mountain section, where a rough surface is desirable to minimize the possibility of skidding and provide a considerable safety factor, the process of construction was such as to produce a surface of rough texture. The bituminous material was applied to the wearing course in a single application of 2½ gallons per square yard, followed by rolling and the brooming in of pea stone, which was applied rather lightly ahead of the roller. In this work, the wheels of the roller were kept wet to avoid picking up the stone.

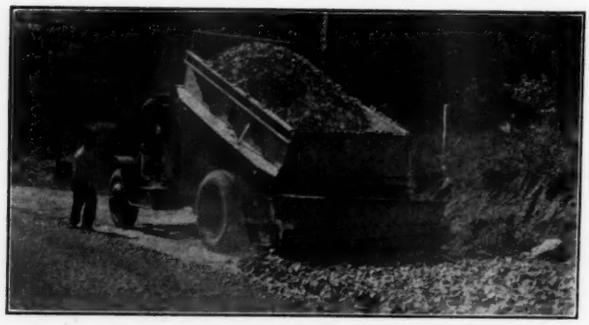
On the lower section, between Charlemont and Cold river, two applications of bituminous material were made. The first application consisted of 2¼ gallons per square yard, following which the pea stone was spread, rolled and broomed. A final seal coat of ½ gallon a square yard was then applied, and another coating of pea stone spread, rolled and broomed in. This gave a non-skid surface, but one slightly smoother than that secured by a single application.

METHODS OF CONSTRUCTION

Particular attention is paid to the details of construction, and these are the subject of rather exact specification, and constant watchfulness on the part of the engineer. Before the base course is spread, the contractor must construct shoulders sufficiently

BUCYRUS-ERIE STEAM SHOVEL HANDLING ROCK; ROAD CONSTRUCTION IN BACKGROUND.

UNLOADING EQUIPMENT AT SIDING. BARBER-GREEN CONVEYOR IN FOREGROUND.



SCHACHT TRUCK SPREADING STONE WITH GALION SPREADER

high to contain the stone and wide enough to permit rolling simultaneously with the broken stone for a width of 12 inches. The stone must be spread by hand from carts, from a dumping board, or from an approved spreader. When dumped in piles on the subgrade, it must not be deposited within the area over which it is to be spread. Special attention is paid to the regularity of the surface. A 3-wheel, self-propelled roller weighing 10 tons or more is required, and the rolling is begun longitudinally at the sides, overlapping the shoulders for a distance of at least 12 inches, and proceeding toward the center, each successive trip overlapping the former by one-half the width of the rear wheel. Rolling is continued until the stones are firmly interlocked, and the surface is true and unyielding.

For the base and surface courses, one roller is required for each 100 tons of broken stone spread per day of 8 hours, in addition to those used on the sub-base and foundation course.

Before the wearing course is spread, shoulders must be rebuilt so as to hold the stone in place and allow at least one-half the width of the rear wheel to lap on the shoulders. Special care is required in depositing and spreading the stone, as in the case of the base course. Rolling requirements are the same. The roller wheels must be clean, to prevent dirt from filling the interstices of the stone. The stone must be dry or application of the bituminous material is not permitted. Pea stone is added in small amounts while the rolling continues, only enough being used to fill the voids. The bituminous material is applied between 300 degrees and 350 degress F for asphalt, and 200 degrees and 275 degrees F for tar.

OTHER CONSTRUCTION DETAILS

Guard Rail and Curbing.—The job requires 27,250 feet of wire cable-concrete post guard rail. This is supplemented in places by the construction of a stone or concrete curbing just inside of the rail. On the section west of Cold River bridge for a distance of about 7800 feet a concrete curb 6 inches thick, 20 inches deep and in sections 6 feet long will be used. This curb will be 10 inches above and 10 inches below the surface.

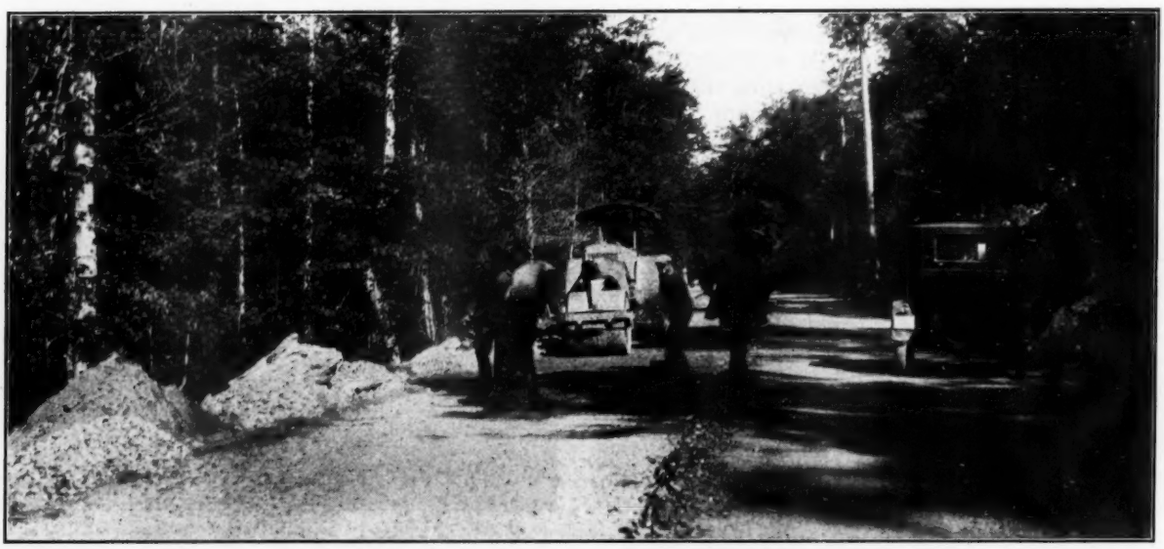
Toe and Retaining Walls—At a number of places, retaining walls are required to prevent slides, or provide for free drainage unobstructed by debris from steep sidehills above. Rough rubble walls are being constructed in these places. Toe walls are also required in a number of places where the toe of the road fill is menaced by high water in Cold river.

Water Supply.—Considerable water was required by the steam-driven equipment on the job. This was provided by damming a small stream well up toward the summit, and carrying the water by gravity about two miles. Owing to the abnormally dry season the water problem became acute, and some of the steam-driven equipment was withdrawn from the work.

Traffic Control.—Traffic control presented no problem because the road was closed entirely to all traffic. This was necessary because it would not have been possible to maintain traffic without great danger to the traveling public. The road was closed even to the contractor for days at a time, when a large blast would block the way with rock until a steam shovel could dig through. Traffic which ordinarily would have used this road, was routed through excellent roads going north and south of the section under construction.

MATERIALS

The crushed stone for the road was all shipped in. Most of it came from the Lane Quarry at Westfield, Mass; some came from the Massachusetts Broken Stone Co., Deerfield. At the east end of the job, near the Deerfield River bridge, the contractor had a side track 972 feet long, on which about 20 cars could be



COMPLETING THE BASE COURSE AT LEFT; FINISHED ROADWAY AT RIGHT.

ROLLING WHILE PLACING SURFACE COAT

accommodated, and on which about 100 cars a week were handled. There were two unloading pits for the stone. From one of these, a bucket conveyor carried stone into a home-made bin. From the other, a Barber Greene belt conveyer loaded stone directly into the trucks.

EQUIPMENT USED

The list of equipment used on the job was large. In addition to the 38 motor trucks, 5 power shovels and drills and air compressors already mentioned, there were 6 rollers, one of which was a Huber gasoline 10-ton; one Buffalo-Springfield steam and one gasoline; and three Acme. There were also a number of smaller graders, light trucks, and other miscellaneous equipment.

APPLYING THE ASPHALT BINDER TO MOUNTAIN SECTION OF THE TRAIL

PERSONNEL

There were usually around 150 men on the job, headed by Daniel and Nicholas D'Onfro. The work is under the general supervision and direction of H. D. Phillips, district engineer for the Massachusetts Highway Department. W. G. Burns is construction engineer in charge, and F. E. Cassidy, assistant engineer in field charge of this and other works in the northern part of the district. E. J. Gorrie is resident engineer and J. J. McCarthy is in charge of surfacing work. W. P. Lawlor and H. F. Tyrell are the office engineers on the work.

The Automobile Peril Twenty-five Years Ago, and Today

In the issue of this journal (then known as "Municipal Journal and Engineer") for November, 1904—just twenty-five years ago—appeared an editorial entitled "The Automobile Peril," which began with the statement: *"An average of a life a day is the startling tribute that New York is paying toward the development of the automobile and the pleasure of its votaries."* While this rate did not continue for any considerable period, to judge by the total fatalities recorded for that year, on the other hand only 55,000 motor cars, including trucks, were licensed in the entire country that year.

While the number of automobiles has increased five hundred times since 1904, the number of fatalities has increased about fifty times. In other words, in spite of the doubling of speed and the more-hours-per-day use of autos, the number of fatal accidents per car has decreased ninety per cent. This is undoubtedly due to increased skill of both drivers and pedestrians in avoiding each other—a skill which is approximating intuition in the younger generation. The present rate can be reduced, perhaps ninety per cent, by putting the fear of jail into the careless and reckless drivers and pedestrians who are responsible for most of the accidents now.

The editorial of 1904 also said: *"Many of the public roads can no longer be used by pedestrians, especially by old persons or children, by riders and drivers of horses, or by bicyclists, without incurring serious risk from the drivers of motor cars and motorcycles."*

This peril persists, with less attempt at amelioration than in the case of city streets, in that no foot path or space for pedestrians other than the paved roadway is provided on our highways. Children walking to and from school in country districts, young people and old walking for health and pleasure beyond the city's sweltering streets, are compelled in most instances to walk on the paved roadways or else struggle through grass and weeds over the rough ground generally found along the sides of the road.

It would add little to the cost of constructing a road, to level off a space on one side of the right of way, outside the part prepared for vehicles, for the use of pedestrians, sloping it toward the roadway gutter for drainage; and the grass and weeds (which should be kept short over the entire right of way in any event) can be mowed more readily on the level paths than on the uneven, often lumpy ground so often left along the roadsides. The importance of the matter is indicated by the fact that the American Society for Municipal Improvements, at its convention last month, adopted a resolution asking its members to endeavor to remedy this condition in their respective districts.

Airport at Port Columbus, Ohio*

Selection and drainage of site and construction of runways and aprons at the eastern air terminal of the air-rail route of the Transcontinental Air Transport between New York and Los Angeles.

By R. H. Simpson†

Funds budgeted by the city of Columbus, O., for a complete airport became available Jan. 1, 1929, and since then a site of 360 acres has been purchased, leveled and cleared; thirty-two miles of sub-drains laid; one hundred and five thousand square yards of pavement constructed; an administration building and two hangars erected; field lighting installed, and other miscellaneous work performed. On July 8, 1929, the airport was formally dedicated and opened for transport service.

The approximate expenditures by the city for the development of the port are listed below. This does not include the cost of structures erected and other work performed by transport companies.

Property	$312,000
Clearing, grubbing and leveling	31,500
Sewers and drains	91,600
Runways and taxiway	135,000
Aprons	30,000
Lighting	23,000
Administration building	60,000
Hangar	110,000
Fences	7,000
	$800,100

SITE

The site was selected by a metropolitan committee and the location approved by aeronautical experts, including Colonel Lindbergh. It is about eight miles east of the business center of the city and may be reached in twenty minutes by either of two main thorofares. It is bounded on the north, east and west by highways and on the south by the joint tracks of the Pennsylvania and Baltimore & Ohio Railways. The proximity of the Pennsylvania Railroad was an important factor in the selection of the site, as the Transcontinental Air Transport, Inc., in connection with this railway, has selected Port Columbus as its eastern air terminal in connection with the joint air-rail route from New York and other eastern points, to Los Angeles and San Francisco. The Pennsylvania Railway Company has built a station at the site, so that passengers may transfer from train to plane or plane to train by a short walk through a covered passage. As far as is known, this is the only air-rail transfer station in the United States.

The site that has been developed is rectangular in shape, 4500 feet long by 3500 feet wide, and contains about 360 acres. An additional area on the north and west of 250 acres, has been acquired for future expansion. The site is generally level. The east end, where the hangars and administration building are located, is 816 feet above sea level, and the field has a total slope, to the west, of sixteen feet.

The field layout provides sites for nine hangars along the taxiway. These lots have a frontage of 225 feet along the taxiway and a depth of 360 feet. They are leased to companies who desire to operate on the field, but the location of the hangars, or other buildings erected, is controlled by the city. The design of the hangars also is under the control of the city, and a policy of requiring the architecture to conform to definite standards has been adopted. One lot has been reserved by the city on which a hangar is being erected. The Transcontinental Air Transport Company and the Curtis Company have erected hangars and the Municipal hangar will be completed this fall. These hangars are 200 feet long, the door openings being 120 feet in the clear. Ample space is provided for parking automobiles adjacent to the station. A strip of land 150 feet wide, along the south side of the field, has been reserved for the construction of an additional thorofare as a means of access to the airport.

A passenger station and administration building has been constructed by the city. This is located adjacent to the railway station, to which it is connected by a covered walk. It is provided with a waiting room and ticket offices; a restaurant and lunch room on the first floor; a manager's office, pilots' lounge and offices for transport companies on the second floor. A tower extends above the roof, in which is located the switch board for lighting the field. The lighting consists of boundary lights, obstruction lights, flood lights and a beacon with zenith ray. (See PUBLIC WORKS for June, 1929.)

DRAINAGE

In the plans for the development of the field some means to remove the surface and sub-surface water was considered of prime importance. The soil at the site consists generally of a twelve-inch layer of black soil underlaid with yellow clay. At a depth of from eight to ten feet the entire area is underlaid with shale. An analysis was made of the soil in different parts of the field and the result indicated the necessity of providing an extensive system of subdrains, as most of the material was heavy clay that would probably drain slowly.

The natural slope of the field is to the west and southwest, but the only available outlet for the drainage system was

HANGAR AT PORT COLUMBUS

*Paper before the American Society for Municipal Improvements, slightly condensed.

†City engineer, Department of Public Service, Columbus, O.

LAYING ASPHALTIC CONCRETE SURFACE ON RUNWAYS AT PORT COLUMBUS, O.
Note strip of white stone along edge of runway.

a deep creek adjacent to the northeast corner of the site, about thirty feet below the level of the field. A natural ravine extends from this creek to the northeast corner of the field.

The sub-drainage lines were constructed at thirty-foot intervals within the runway area. A sixty-foot spacing was provided for all other areas. Three lines were laid directly under the runways. Drains were constructed along each side of the paved runways and on the lower side of the taxiway, so that rainfall on these paved areas would be removed promptly. The tile trenches were backfilled with gravel to a point eight inches below the surface, the top of the trench being filled with earth. Along the runways and taxiway an eight-inch layer of coarse limestone was placed on top of the gravel fill and brought to the surface. No drains less than five inches in diameter were used. The drains were all laid to grade with a minimum slope of two-tenths of a foot in a hundred. The average depth was about three feet and minimum cover two feet. About thirty-two miles of drain were laid in an area of 200 acres. The size of subdrains was determined on the basis of providing for three-fourths inch rainfall runoff in twenty-four hours or about one cubic foot per second for each thirty acres. The size of the drains which intercept water from paved areas was based on providing one cubic foot per second capacity for each 200 lineal feet of runway.

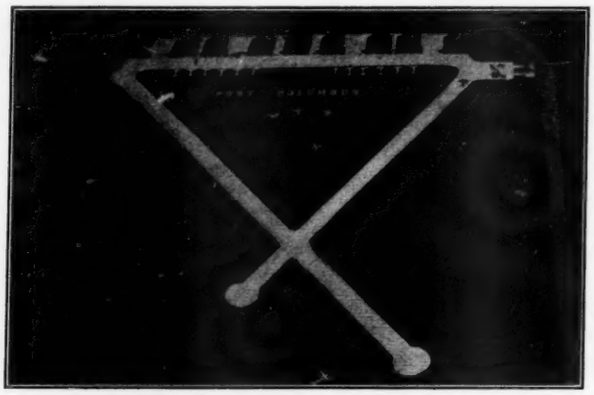
The main outlet for the system is forty-eight inches in diameter and was constructed of reinforced concrete culvert pipe. The main laterals are A.S.T.M. standard vitrifield sewer pipe. The subdrains are extra-quality vitrified shale drain tile, as per A.S.T.M. standard specifications. The eight, ten and twelve-inch subdrains along the runways and taxiway are extra-thick, extra-quality tile, the increased thickness of wall being one-fourth inch in each case. Storm drains have been provided to carry roof water from all structures, and sanitary sewers with septic tanks installed, with connections to the administration building and all hangars. Water supply and fire protection is obtained by the extension of city water mains to the site.

RUNWAYS

In planning the development of the field, it was considered of prime importance to secure such a surface that planes could take off and land regardless of weather conditions. This requires a smooth surface with no abrupt changes in grade, and one that is free from mud, dust or other loose material. It was felt that a good, strong turf, such as has been developed in many airports in Europe, would meet all these requirements, but it was recognized that it takes a long time to grow a good turf that will not be destroyed by heavy use, and, as it was important to develop the airport so that it could be used as soon as possible, the construction of takeoff and landing areas was absolutely essential.

It was recognized that if the field were to be put in operation without delay it would be necessary to construct paved runways in at least two directions. The length and width of the runways was fixed at a conference with the technical advisors of the Transcontinental Air Transport Company. The one in the direction of the prevailing winds, that is northeast, is 3500 feet long, and that in the direction of the high velocity winds, that is northwest, is 2500 feet long. The two runways cross at a point about 2000 feet from their east end. A taxiway runs north and the direction of the prevailing winds, that is northeast ends of the two runways. Adjacent to this taxiway, paved aprons afford access to the hangar. The runways are 100 feet wide, the taxiway is 30 feet wide, and the aprons connecting the latter with the hangar are 120 feet. An apron 200 feet wide extends south to the administration building and is used as a passenger loading platform. The triangular space between the runways and west of the hangars, as well as for a considerable distance on either side of runways, is now being seeded and will, in time, be covered with turf.

In the longitudinal direction the runways were laid to a grade that would fit the ground as closely as possible. These grades are so flat that it was necessary to drain them at right angles to the runways. To accomplish this they were constructed with a slope of six inches in the width of 100 feet and without



LAYOUT OF PRESENT RUNWAYS AT PORT COLUMBUS

any crown. The water is caught in a gravel-filled trench at the edge of the runways and carried away in a tile at the bottom. There is also a subdrain constructed in a similar manner on the upper side of these runways in order to intercept any water that might flow down toward the paving from the adjacent field. An eight-inch layer of crushed limestone was placed on top of the trenches. This layer of stone is three feet wide and gives a white outline to the runway from the air.

The design of the paving of both runways and taxiway called for a one and one-half-inch asphalt surface laid on a five-inch concrete base, and was based on the assumption that the sub-grades would carry the load. This required, of course, a dry and stable sub-base. In addition to the drains at the edges of the subways, three lines of tile were laid under the pavement and connected to the main drains at frequent intervals. The soil was rolled and where soft spots were encountered the material was removed and the spaces filled with coarse limestone and compacted by heavy tractors and finally by a roller.

The concrete base was constructed under our standard specifications for pavement bases. It was mixed in the proportion of one cement to eight of aggregate and was five inches thick. The top surface was finished rough so as to furnish a mechanical bond for the asphalt surface. Expansion joints every 400 feet were provided in the concrete base. These were eight inches wide and filled with asphalt concrete, compacted by tamping.

On account of the soft condition of the field after rains, it was necessary to haul the aggregates when the field was in condition for hauling and store it in stock piles. Mechanical loaders were used to load batches into small trucks which served the mixer.

ASPHALT SURFACE

The asphalt concrete surface consists of a mixture of bitumen and mineral matter in accordance with the folowing specifications:

Bitumen	5% to 6%
Mineral matter passing 200 mesh screen	5% to 6%
Mineral matter passing 80 mesh screen	8% to 10%
Mineral matter passing 40 mesh screen	12% to 15%
Mineral matter passing 10 mesh screen	8% to 10%
Mineral matter passing ¾ inch screen	55% to 65%

The mixture as laid averaged as follows:

Bitumen	6%
Mineral dust	6%
Sand	28%
Stone	60%

This was found to give the results desired: viz. a dense mix but with a roughened surface texture.

The bitumen used was asphalt refined from Mexican oils. The 200 mesh material was limestone dust from local quarries. The 80, 40 and 10 mesh material was Lake Erie sand, and the coarse aggregate was crushed limestone from local quarries. The material was heated and mixed at a standard point, under standard specifications, and hauled to the site in trucks. It was raked and spread in the usual manner and rolled with ten-ton tandem rollers.

The contractor laid the asphalt concrete surface, amounting to 90,200 square yards, in thirteen working days, an average of 7000 square yards per day. The maximum laid in one day was 9600 yards. The haul was about nine miles and eighteen trucks were used to haul the mixture to the job.

APRONS

A concrete pavement 45 feet wide was constructed immediately adjacent to the taxiway for its entire length, and concrete aprons 75 feet wide connect each hangar with this pavement. This concrete pavement was divided into slabs 45 feet wide and 60 feet long. It was made 6 inches thick, with all four edges of each slab thickened to 7½ inches. The slabs were keyed together by tongue and groove joints.

The acquisition of the property was handled by the legal department of the city. The design and construction of the administration building and municipal hangars was under the direction of the Allied Architects Association of Columbus. The clearing and leveling of the field, construction of sewers and drains, and of runways, aprons and other paving, were done by contract under the general supervision of the city engineer as chief engineer of the Division of Engineering and Construction.

Emergency Chlorination

Early this summer, the State Department of Health warned water supply officials of the probable necessity for using auxiliary water sources if the drought continued and offered to install emergency chlorination equipment in cases where such auxiliary supplies were not of satisfactory quality. As the drought continued and shortages in many instances became serious, engineers were held subject for immediate assignment in emergency cases.

Over thirty municipalities suffered a shortage of water before the drought broke and the emergency apparatus was called into use in a number of cases.

Despite the unusual conditions no water-borne outbreaks occurred.

Periods of drought are frequently followed by periods of excessive rainfall. Waterworks officials are therefore urged to inspect their watersheds now to make sure that there are no accumulations of filth which surface wash might carry into their public supply.—*"Health News" of New York State Department of Health.*

Important Phase of Engineering Too Often Not Considered

Build and Be Gone

By Henry W. Taylor

For some years Ohio has pioneered in insisting that provision for maintenance shall be made before permits for construction of sewage treatment plants are issued. The same policies are now being applied by an increasing number of states. Discussions at recent meetings of sewage works operators show the fundamental soundness of such policies, and the widespread interest in their application.

The Editor will be glad to receive comments or discussions on this subject.

Some time ago the writer visited a sewage disposal plant constructed under his supervision. He had some trouble finding it, due to the density of the undergrowth. A brief inspection left the impression that the feature of engineering technique which proved most effective in this particular case was the careful selection of a secluded site, where the plant could revel in an undisturbed rot.

Such a case is, fortunately, not an average one, but it is far too common. A more average situation is represented by a certain water works improvement designed and constructed under the supervision of this office where the handwriting on the wall was detected in advance and some self-protection was applied by insisting on supervision of operation for a limited period of time. This supervision of operation extended over a sufficient period to satisfy the tax payers that the money involved in improvements had been spent for some good purpose. However, the writer is still under the necessity of insisting upon a second period of supervision of operation in order to see to it, for his own protection, that various matters are attended to and the system is in proper form for the winter and spring season.

A parallel situation is also evidenced by the friction between the construction and operating departments of the larger organizations. In the mind of either, the other department is of small value and the buck is passed from one to the other, in many cases with complete justification. Design and construction can hardly be widely divorced from operation without crippling both and without loss of benefits which should be derived by a closer relationship.

Similar cases might be multiplied without end, and though the degree of necessity for maintaining general supervision over newly constructed work varies widely, the basic principle is ever the same and points to the fact that the existing engineering system of Build and Be Gone is full of danger to the engineer, to the owner and to the work. It leaves the engineer without protection to his professional reputation; it frequently wastes good money well spent; it often depreciates good results where good results are a public or private necessity.

Observation of the policy of manufacturers has indicated a similar need in the field of equipment and instruments. The manufacturers are gradually educating purchasers to allow them to set up their own apparatus, to make periodical inspections of their product and regular tests of apparatus and instruments. All engineers are familiar with many cases where inspection of pumping or power apparatus, with the resulting adjustments, would have saved thousands of dollars to the owner if this inspection and repair had been undertaken at the proper time. I know of manufacturers who have entirely abandoned the idea of selling their product for installation by others unfamiliar with it, and the majority of cases of unsatisfactory operation of apparatus are due to the installation of it by other than the manufacturer and operation by those unfamiliar with it.

The manufacturer's attempt to protect his product represents an effort parallel to that which should be made by engineers to protect their designs and their structures. It might well be the policy of any office to undertake no construction, such as a sewage disposal plant, for instance, except when assured that a general supervision of operation will be permitted until such time as local troubles have been experienced and solved and operators have been trained to know the plant and the ways and means of meeting situations as they occur.

The elements which give rise to the neglect of operation are not political or confined to organizations but are individual.

I have taken pains on several occasions to investigate the private business of a man who objects to public expenditure for operating purposes and have found that he applies the same policy to his own business and his plant shows evidence of it. There is also a mysterious sentiment abroad that a complicated plant which the layman does not understand has an unexplained human intelligence and that it will float along on its own intuition without material assistance. Another element which has either produced or aided the continuance of the present evil is the old slogan of manufacturers and others that you can install their apparatus and forget it. Often operating expenses have been belittled for fear of killing construction.

It may be said that a poorly designed plant can be made to operate with careful operation; and it is equally true that a perfectly designed and constructed plant can soon go to pieces without such operation. Furthermore, it is doubtful if the old alibi of having built but not operated plants will much longer be endured and no matter what the conditions or the history of the plant and its operation, bad results from it will draw a dirty thumb across the construction record of the engineer.

It is also easily possible that were the engineer to

follow along with the operation of the completed plant, this operating experience might materially affect his subsequent design. It would make the operating engineer more familiar with the human problems of personnel which must be met so far as possible in design as well as in operation, and there would, no doubt, result an adjustment between theoretical design and human frailties.

The present evil can be overcome gradually by the insistence of the engineer that after construction he retain operating control for a period sufficient to demonstrate the workability of his project. Such a preliminary insistence should further develop into the education of the owner to appreciate a real economy rather than an added expense in such supervision. It would also cure a collateral evil in engineering practice where the theory is that of Build and Be Gone as quickly as possible, and the assured advisability of not returning to any given locality after the first work has been done there.

It may be considered by some that political, personal and human considerations stand stubbornly in the way of such a program. The field of the engineer, however, cannot be confined to technical problems and it includes a competent business judgment and a study of human nature and the capability of handling the human element in engineering work as well as the structural and process problem involved. It appears that certain of our State Departments of Health are realizing the evils of the existing system and are at least requiring, prior to sewage disposal construction, the assurance of a sufficient amount of money to maintain the plant properly under some supervision.

In larger communities and organizations there are, it is true, many instances of elaborate supervision of operation at considerable cost, and from these sources much valuable information has been obtained. The operating supervision referred to here is that required for the more average case and does not ncessarily involve large expenditure for laboratories and many assistants. It is a supervision that is based fundamentally on past experience and good judgment, applied with a degree of common sense and some knowledge of human nature. It involves a central control, training of operators, elimination of an undue amount of stubbornness and hide-bound ignorance, and tact in getting the various departments or bodies to work in some degree of accord. There is also included in this supervision of operation, the willingness to learn additional facts and plans of operation and profit by them, and the ability to give the local man credit where credit is due and to eliminate the assumption that he knows little or nothing, which may or may not be the case.

Missouri Water and Sewerage Notes

Plans for a water and sewage system for Norborne, Missouri, have been approved by the State Board of Health.

DeSota, Missouri, has passed a bond issue for $110,000 to construct a sewer system and sewage treatment plant.

Special investigations recently have been made by the sanitary engineer of the State Board of Health on the sewage treatment plants at Sedalia and Rolla.

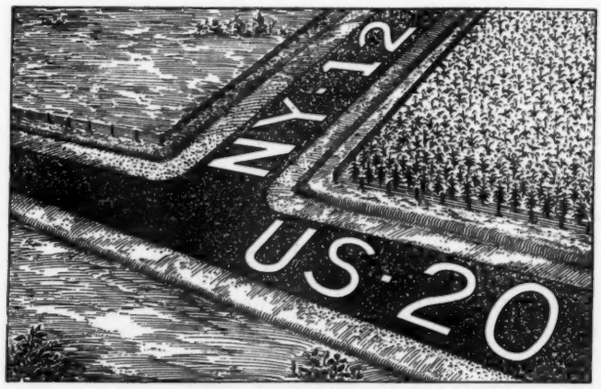
Signs on Highways for Air Pilots

United States Department of Commerce recommends that official route numbers of Federal and State highways be indicated at intervals by means of letters ten to thirty feet high, to enable air pilots to locate themselves.

The chief of the Division of Airports and Aeronautic Information of the U. S. Department of Commerce, Harry H. Blee, recommends the use of the main highways of the country for signs indicating to air pilots their exact location. Said Mr. Blee: "A highway, when viewed from the air, stands out very clearly and is therefore one of the pilot's best landmarks if he knows what highway it is. As soon as surface arteries of motor travel, particularly the federal and state roads, are properly marked to facilitate their identification from the air, they will constitute an extremely helpful aid to air navigation by enabling any pilot to check his position by a glance at the map. The general use of a standard system of air marking that will convey the necessary information to aircraft pilots, in the simplest and most effective manner, is today one of the most immediately needed aids to air navigation; and it is very important that the highway system of the entire country be properly air marked. It is urged, therefore, that the air marking of highways be undertaken wherever possible."

The marking recommended by the Department of Commerce consists of letters from 10 to 30 feet high, depending on the width of the pavement, and giving the official route number of the road, preceded by the letters U. S. in the case of federal highways, or by the state abbreviation for state highways. The marking should read from west to east or from south to north, and should be placed at all intersections between main highways, with other markings if necessary to reduce the intervals to not longer than ten or twenty miles along each route. Mr. Blee stated that any good grade of chrome yellow or white traffic paint may be used, preferably with two coats, but recommends that chrome yellow be used whenever possible. For light-colored pavement, the chrome characters may be outlined in black.

The above would be practicable only for concrete, asphalt, brick and other hard-surface pavement. Apparently no suggestion is offered applying to gravel and other non-durable surfaces.



AIR MARKINGS RECOMMENDED FOR HIGHWAYS

THE EDITOR'S PAGE

Table of Contents

The table of contents, which heretofore has been found—or at least has been published—on the Editorial Page, has been transferred to the right-hand page immediately preceding reading matter. The change was made because readers had complained of difficulty in finding it. We hope the new position will prove to be more readily discoverable.

Highway Safety and Wide Streets

Nearly one hundred people a day are being killed by motor vehicles in the United States, and several hundred injured. This represents a loss of money value in lives, in hospital bills and lost wages, of nearly five hundred million dollars a year, or about four dollars for each man, woman and child in the country.

These figures are startling. But the fatalaties per motor vehicle in England and on the continent are, it is reported, considerably higher. Also statistics show that fatalities from falls and other accidents in homes in this country number three-fourths as many. This is said with no purpose of minimizing the seriousness of the highway peril, but to suggest that a panicky feeling should not possess legislators and traffic officials, resulting in impulsive adoption of suggestions that are illadvised and may cause more harm than good.

In a statement issued in October by the American Road Builders Association is the assertion: "Traffic congestion and the death toll increases. . . . No amount of safety precautions will be effective without wide roads and streets." This we most emphatically question. In fact, we believe that wider streets will increase the number of fatalities rather than decrease them.

Considerably more than half of those killed in motor accidents are pedestrians. We can see no possible reason why a wider street is safer for the pedestrian, even if there are but two lines of traffic to watch; on the other hand, he is in peril for a longer period of time than when crossing a narrow street. But a wide city street usually carries more than two lines of traffic —if it does not, the chief argument for widening is lacking. And with three or more lines of traffic to watch, the peril to the pedestrian is increased; in fact, we would estimate the peril to increase approximately as the square of the number of lines of traffic which the pedestrian must cross to reach the other side of the street or an isle of safety in the center of the roadway.

As to danger to the motor vehicles, we believe traffic experts do not consider that this is made less by widening a roadway, where it is already sufficiently wide for two lines of traffic, plus parking space in the case of city streets. At any rate, decrease in peril due to widening of city roadways is not yet sufficiently demonstrated to warrant the enormous cost such widening involves in most cases; and the interweaving of vehicles between several lanes of traffic not separated by fences or curbs is believed by many to introduce additional peril to all.

This is not to say that many city streets and country highways should not be widened so as to carry more traffic; although a number of traffic experts deny this as a general statement, claiming that the same money spent in paving additional parallel routes would give more adequate returns to a larger number of vehicles.

We sympathize with automobilists in wishing for wider roadways but we do not believe they are justified in asking for them on the plea of reducing accidents. Instead, pedestrians would seem justified in insisting that city roadways be not widened to carry more than two lanes of traffic.

Disposal of Organic Wastes

During the World War, patriotism included saving peach stones for gas mask carbon, saving our Sunday newspapers, and transforming garbage into hog meat and fat. But during that period most of the acts of our lives were abnormal; and because it was almost criminal then to burn garbage and sewage sludge, is no argument that such disposition of waste organic matters is not now permissible and even praiseworthy.

What is the proper disposition of waste organic matters should be decided solely on the basis of sanitation, convenience, dollars and sense—no idea of "conservation of resources" enters into the question. Anything found in garbage, from beans to beef, could be replaced in a year or two with very little effort—the destruction of it inflicts no hardship on the coming generations. Sewage sludge may provide good fertilizer base, but there are plenty of other matters available which are just as good.

The dollar consideration is of little more importance, although it seems difficult to make the taxpayers, or even their officials, realize it. (That is another story. We will probably have something to say about it next month.) If each individual in the country of movie-going age would cut out one movie a year, the saving would pay the entire cost of disposing of all the garbage of the country by any of the standard methods. And the country pays more for chewing gum than would be required to dispose of all its sewage by the most up-to-date methods, including oxidation and chlorination.

There remain then sanitation, convenience and sense, and the greatest of these is sense—"common sense;" so called, someone has said, because it is the least common thing on earth.

If the above statements are not greatly exaggerated, common sense would seem to indicate that proper disposition of liquid and solid wastes requires the total destruction of all matters that may injure the health of any human beings, and in such way as will not give any offense to any of their senses. This having been assured, whatever profit can be made or reduction in expense effected is so much "velvet."

But conservation of resources and expense (other than waste of money) are the least considerations in solving the waste disposal problem.

Cost Data at the Baltimore Sewage Works

Under the above title there was published in Sewage Works Journal for July an article by C. E. Keefer, engineer of sewage disposal of the Bureau of Sewers of Baltimore, Md., which described the methods employed in that city for keeping accounts of the cost of maintenance and operation of its sewage works and presented a tabulated statement of the cost of the works for the years of 1921 to 1928 inclusive.

He classified the costs under the general heads of Fixed Charges and Operating and Maintenance Costs. To learn the interest and depreciation, which come under the first head, it is necessary to know the first cost of the plant. This is usually known from the records, and should include not only the money paid contractors for construction expenses but also such items as the cost of the property on which the plant is built, engineering and architects' fees, administrative and overhead expense, discount on the sale of stock, and other preliminary expenses. To this first cost should be added improvements made from time to time, when these are additions to the plant and not to replace worn-out parts of the plant already included in the capital cost.

In estimating the probable life of the plant upon which depreciation is based, obsolescence may be more important than actual physical deterioration. Depreciation of the Baltimore plant is based on an assumed life of 33⅓ years, although plans are already being prepared for extensive changes in the plant, which has been in service for only 17 years. Mr. Keefer prefers the sinking fund method of determining annual depreciation rather than the straight-line method or the diminishing value plan.

In recording operation and maintenance charges, it is desirable to know the cost of running the various treatment units of the plant as well as the operating cost of the entire plant. For this purpose, the superintendent assigns charge numbers to each phase of the operation, such as screening, grit removal, sedimentation, oxidation, sludge digestion, sludge drying, and the maintenance of grounds. The expenditures are then segregated to these various heads and also to labor and materials under each head. Where all or part of the plant is operated by electric power, wattmeters should be provided to register the power consumption by various units of plants. Complete segregation of the cost would involve separating into "labor" and "material" all items classified under the general heads of "operation" and "maintenance," for each phase of the operation. Operating charges should include such items as labor required to clean sewage screens, to attend to the operation of settling tanks, to remove sludge from drying beds, electric power to operate sewage and sludge pumps, chlorine used for treatment purposes, chemicals and supplies. Maintenance charges are embraced in such items as labor and materials needed for repairs, the painting of buildings and the storage of materials and supplies. In the case of new equipment purchased for the sewerage plant, this would be classed under first cost if it added a new feature to the plant; it would be charged to "depreciation reserve" if it replaced a similar piece of equipment which had worn out, or to "maintenance" if it replaced one or a part of one which had been damaged.

In the personnel of the Baltimore Sewage Works, the number employed remains quite constant except for laborers on sludge drying beds and on the maintenance of grounds. In connection with the former, as many as three gangs of ten men in a gang are needed at times for cleaning the beds, while during the spring and fall one gang is sufficient. In main-

Table I

Cost of Sewage Treatment at Baltimore

Year (1)	Average Sewage Flow M. G. D. (2)	Population Contributing Sewage[1] (3)	Total Cost of Plant (4)	Fixed Cost: Interest 4.1% Plus Depreciation 1.5%[2] (5)	Fixed Cost: Per M. G. of Sewage (6)	Fixed Cost: Per Capita per Year (7)	Operating Cost: Total (8)	Operating Cost: Per M. G. of Sewage (9)	Operating Cost: Per Capita per Year (10)	Fixed Cost and Operating Cost: Total (11)	Fixed Cost and Operating Cost: Per M. G. of Sewage (12)	Fixed Cost and Operating Cost: Per Capita per Year (13)
1921	46.62	536,952	$3,337,100	$186,877.60	$10.98	$0.348	$ 76,656.02	$4.51	$0.143	$263,533.62	$15.49	$0.491
1922	47.49	556,400	3,344,100	187,269.60	10.80	0.337	106,384.26	6.14	0.191	293,653.86	16.94	0.528
1923	48.17	578,755	3,496,000	195,776.00	11.14	0.338	103,983.21	5.91	0.180	299,759.21	17.05	0.518
1924	53.50	608,127	4,027,600	225,545.60	11.52	0.371	106,945.52	5.46	0.176	332,491.12	16.98	0.547
1925	55.09	647,080	4,257,800	238,436.80	11.86	0.368	108,048.90	5.37	0.167	346,485.70	17.23	0.535
1926	58.54	681,962	4,392,400	245,974.40	11.51	0.361	103,399.73	4.84	0.151	349,374.13	16.35	0.512
1927	59.62	702,827	4,584,000	256,704.00	11.80	0.365	104,418.00	4.80	0.149	361,118.00	16.60	0.514
1928	63.49	714,032	4,601,900	257,706.40	11.09	0.361	107.632.79	4.63	0.151	365,339.19	15.72	0.512

[1] Estimated as of July 1.
[2] Depreciation based on a useful life of 33⅓ years.

Table II

Cost of Operating the Baltimore Sewage Works

No.	Treatment Unit	1921	1922	1923	1924	1925	1926	1927	1928
1.	Bar screens	$ 5,469.19	$ 5,544.34	$ 4,571.48	$ 5.454.52	$ 5,790.73	$ 6,207.70	$ 6,119.19	$ 5,928.62
2.	Settling tanks	8,974.66	11,733.60	16,944.95	17,372.38	17,231.64	16,880.86	18,650.84	21,205.66
3.	Imhoff tanks	4,822.11	3,640.52	3,536.68	2,896.14	.....	.....	.....	.....
4.	Revolving screens	10.987.67	13,289.15	13,518.24	10,694.38	13,171.15	8,809.55	9,184.28	4,898.37
5.	Trickling filters	11,500.72	16,599.40	12,602.55	16,247.69	13,483.48	15,583.68	13,608.66	14,276.39
6.	Final settling basins	3,491.19	3,437.87	4,972.45	5,190.52	4,287.61	3,805.83	4,307.50	3,793.64
7.	Sludge digestion tanks	8,057.62	9,534.16	12,780.20	14,187.11	16,078.24	13,122.31	10,891.97	11,318.71
8.	Sludge drying beds	13,262.19	18,181.37	23,300.63	23,558.90	23,601.03	25,001.21	25,311.14	24,099.49
9.	Final sludge disposal	2,090.67	16,331.68	506.38	.....	.....	2,561.34	4,242.99	7,643.39
10.	Maintenance of grounds	8,000.00*	8,092.17	11,159.65	11,343.88	14,405.02	11,427.25	12,101.43	14,468.52
	Total	76,656.02	106,384.26	103,983.21	106,945.52	108,048.90	103,399.73	104,418.00	107,632.79

* Estimated

tenance of the grounds, the cutting of shrubbery and grass frequently requires the temporary services of several more men than are needed throughout the year.

Table III
Personnel of the Baltimore Sewage Works

Title	Number Employed	Salary
Supervising Force		
Superintendent	1	$2800 per yr.
Chemists	4	$1600 to 2500 per yr.
Clerk	1	$1600 per yr.
General Operating Force		
Foreman	1	85c per hr.
Operating engineer	1	$1800 per yr.
Sewage sampler	1	50c per hr.
Storekeeper	1	50c per hr.
Janitors	2	30c and 45c per hr.
Watchmen*	2	45c per hr.
Laborers	12	45c per hr.
General Maintenance Force		
Machinists	2	75c and 80c per hr.
Electrician	1	$1900 per yr.
Carpenter	1	70c per hr.
Chauffeur	1	50c per hr.
Helpers, handymen, etc.	5	45c and 50c per hr.
Bar Screens		
Laborers*	2	50c per hr.
Settling and Sludge Tanks		
Laborers	10	45c and 50c per hr.
Revolving Screens and Trickling Filters		
Operating Engineers	4	$1500 to $1600 per yr.
Laborers*	2	45c per hr.
Sludge Drying Beds		
Foreman	1	65c per hr.
Locomotive operator	1 to 2	50c per hr.
Laborers	10 to 22	45c per hr.
Final Sludge Disposal		
Crane operator	1	55c per hr.
Maintenance of Grounds		
Laborers	2 to 8	45c per hr.
Total	69 to 88	

NOTE: Supervising force works 38½ hrs. a week. Remainder of personnel works 48 hrs. a week except as noted. The salaries paid during 1928 totaled $89,186.55.
*Work 56 hrs. a week.

The Painting of Water Tanks

By A. H. Sabin, M. S., D.Sc.*

A water tank, like a leader pipe on a house, is one of those things which rust more often from the inside out than from the outside in. The reason is that its interior is seldom kept as well protected against corrosion as the exterior. Not infrequently the only painting the inside of a water tank receives is the one it gets when the tank is built. It is also too often the case that this first and only painting is of a doubtful nature. Unfortunately it seems to be the main idea in some instances to see how cheaply the work can be done in order to keep down the initial expense of constructing the tank, painting being regarded as a more or less unimportant matter which may be of minimum cost.

The fallacy of not properly protecting the interior at the time a tank is built is seen when it is considered how inconvenient it is to paint the inside thereafter. The water must be let out and the tank put out of service. If nothing else, that means great inconvenience. Moreover, once a tank is completed, it is not always easy to reach its interior. Few tanks are so designed that their interiors are very accessible.

The interior of a water tank should receive three coats at least of the best paint obtainable. Four coats are better. Before any paint goes on, the surface should be brought to the most perfect condition possible. Only skilled hands should do the painting. Equally important is it that adequate drying time be allowed between coats. Then, if the water is not unusually corrosive, the interior of the tank ought to be safe for from five to ten years, although it is always wise to empty the tank once a year and carefully examine it. If any small rust spots are found, they should be attended to. With such care, and complete repainting at stated intervals, there is no reason why a tank should not last a lifetime in most cases.

Impurities in water often cause trouble. On the other hand a very pure water, one almost free from mineral salts in solution, is more corrosive than a water containing an appreciable amount of carbonate of lime. The latter neutralizes acids present in the water and also forms a film of insoluble lime carbonate which has protective effect.

Rain water has a good name but, where the air is contaminated with smoke and sulphurous gases, rain water is corrosive. Even in the country it is sometimes corrosive.

It is a good rule for general painting that, of several coats of paint, the first one applied should be the least elastic and each succeeding coat more elastic than the one under it; that is, softer or containing more oil. As the different coats harden by exposure it comes about finally, if all are proportioned rightly, that the whole mass acquires the same hardness and expands and contracts the same in all parts so that it does not crack. On the other hand, if the outer part is harder than the rest of the film, that outer part will crack due to the fact that it is unable to stretch to the same degree as the section underneath when the material carrying the paint expands. Painters call this "an elastic undercoat crack." It is the most common form of the serious cracking defect.

But conditions under water are different, and here the rule of making each coat softer than the previous one does not hold good. The effect of continued soaking in water is to soften slightly even the most insoluble paint. Therefore the outer coat, which will be in direct contact with the water, must be made hard in this case. This is generally accomplished by using a larger proportion of pigment. With red-lead, however, the desired hardness has been obtained most successfully by adding five to ten per cent of litharge, the lower oxide of lead, to the paint. The litharge combines, to a considerable extent, with part of the oil and makes the film much harder and more resistant than it would be otherwise. Because it has this reaction with oil, the litharge is not put in at the time the paint is made up. The proper procedure is to mix it well with spirits of turpentine and then to add the mixture to the paint shortly before application. Sometimes turpentine substitute, a heavy benzine, is used in place of real turpentine. Handled in the manner described, litharge will not affect the free brushing qualities of red-lead paint.

In the case of a three-coat job, the first coat may be a heavy red-lead paint, the second coat one to which a little of the litharge mixture has been added, and the third coat one containing the full amount of this extra pigment. The litharge really might be called "a chemical reagent."

The practice of adding litharge to red-lead paint for under-water work is now of many years standing. It is fully endorsed and recommended. Ample references for its use can be given.

Litharge would not be used in the paint for the outside of the tank. A tank's exterior is treated just like any other steel structure.

*Consulting Chemist, National Lead Company.

Central Blacksmith Shop Solves Drill Problems

Methods employed by a firm of contractors to solve the problems of supplying sharpened drill steel to a number of jobs scattered over a wide area. Economy and advantages.

By Lester H. Burns*

Those who have had much experience in rock work agree that more than half of all rock drill troubles is directly traceable to the poor condition of the bits and shanks on the drill steel. They also agree that the best steel available is by far the cheapest in the long run.

Poirier & McLane, contractors of Yonkers, New York, have given much thought and study to the question of supplying properly sharpened and shanked drill steel to the various points where they have work in process. As a general rule, the duration of their individual jobs is not great, and much of the work is spread over a considerable area. They have found that, all things considered, better results are obtained from a permanent, centrally located blacksmith shop than from temporary shops on their various jobs.

Their blacksmiths work much more efficiently, and the bits are dressed better and are tempered better in a permanent shop than could be hoped for in temporary shops.

The first centrally located shop worked out so well that the contractors recently decided to erect a permanent building for this class of work, and to equip it with the newest and most up-to-date compressed-air-operated machines. This shop is located at the northern limits of the City of Yonkers, and at a point close to the main highways, which afford easy access to all points in the county. It is a steel frame building having four extra-large windows and two garage-type doors, which, when thrown back, open the entire front and admit light and air.

The equipment in the shop consists of an Ingersoll-Rand drill steel sharpener, an oil furnace, a pedestal grinder, and other accessories, all of which are operated by compressed air furnished from an Ingersoll-Rand Class ER stationary compressor, electric-motor-driven.

The capacity of one modern sharpening machine is great enough to take care of all the steel required on a number of ordinary contracting jobs. It is not uncommon for a good operator and a helper to sharpen and temper as many as 500 drill steel in an eight-hour shift; and such steels are true to shape and gauge, and are absolutely symmetrical. The cutting edges form a perfect 45° angle, with the corners of the bits brought out full. The steel is also worked at the proper temperatures so as to avoid "cold-shots," decarbonization, cracks, and internal stresses and strains.

Many blacksmiths forget that the shank of a modern hammer drill steel is almost as important as the bit itself. Such a shank receives anywhere from 1000 to 2000 sharp blows per minute, and must be kept smooth, true, and square with the steel. It must also be properly oil tempered so that it will not chip or batter. The length of the shank to the lug must also be kept within definite limits so that the drill will not short-stroke or strike the fronthead. When the shop is equipped with a suitable grinder, it is a matter of but a few moments to true up a drill shank when it starts to wear down to any appreciable extent. In this way, a shank can frequently be restored to perfect condition without even being heated.

Poirier & McLane have found that with one fast, light truck it is not difficult to collect dull steels and deliver the sharpened lots. The nature of the rock on any particular job is quickly determined, and it is an easy matter to figure closely the number of sharp steels required over any given period. There

* Ingersoll Rand Company, 11 Broadway, New York City.

BLACKSMITH SHOP OF POIRIER & McLANE, YONKERS, N. Y.

PEDESTAL GRINDER IN BLACKSMITH SHOP

need be no waiting for steel, and delays can be eliminated. Any contractor knows how often such delays occur when the blacksmith shop is located right on the job.

With a centrally located shop, a little larger initial supply of steel may be required, but this has its advantage in that the steel is allowed more time to rest between periods of use. This additional time is generally thought by metallurgists to increase definitely the life of steel, as it allows the molecular structure more time to readjust itself.

Originally the shop of Poirier & McLane was intended to take in some outside work, but the company's operations have grown rapidly. They have recently added additional portable air compressors, and the shop is now kept running at full capacity on the company's own drill steel.

No detailed figures are available, but it is estimated that the cost per bit sharpened is approximately two-thirds of what it would be if the steel were handled in individual shops.

OIL FURNACE AND DRILL SHARPENER IN BLACKSMITH SHOP OF POIRIER & McLANE, YONKERS, N. Y.

Road Improvements in Czechoslovakia

In an article by Joseph Svoboda, C. E., Ministerial Counsellor, published in No. 13 of the Public Service Technical Reports of Czechoslovakia, it is pointed out that for 1928 the road fund budget included an item of 16 million crowns for the improvement of the non-state roads, while in view of last year's surplus of the fund, a sum of 68 millions has been appropriated for this purpose in 1929. Judging from the number of applications received for participation in this appropriation, it is clear that this year, and more particularly next year, construction and other activities on the non-state roads will be very brisk.

According to the road fund act, monies from the fund can only be devoted to the improvement of such county and district roads, as well as the communal roads of the main towns, as are particularly important for transport, and proof of this must be given in the applications by statements showing the number and the weight of the individual categories of vehicles using the roads. Contributions from the road fund may only be applied to improving roads, not to their mere upkeep or to the construction of new roads.

Under the improvement of roads is understood such treatment as makes them suitable for motor traffic, improvement of alignment, the removal of steep inclines and dangerous bends, the strengthening of bridges, etc.

Applications for a contribution from the road fund for the improvement of non-state roads must be handed in to the appropriate district authorities in the case of district roads, to the county authorities in the case of county roads or of roads for whch the main towns of the individual provinces are responsible.

Great progress has been made in road construction methods during the past ten years. New construction materials have been introduced as well as new machinery and implements, so that it is possible to make the roads fit for carrying the traffic for which they are intended.

Road mending in Czechoslovakia, according to experience, costs in the case of simple rolled surfaces about 14 crowns per square metre, a double tar surface for light and quick traffic costs about 13 crowns per square metre, a double treatment with asphalt or tar emulsion about 18 crowns per square metre.

For medium-heavy traffic, cement macadam is used, a 4-centimetre thick layer of cement mortar being applied to the levelled and rolled surface of the road. On this there is spread a layer of road metal to a thickness of 10 to 12 centimetres, which is then rolled until the mortar fills the spaces between the stones of the road metal and forms a thin layer on the surface. The outlay for this entails an increase of about 7 crowns per metre on the cost of ordinary rolled surface. Road-metal surfaces treated with boiling asphalt or tar cost about 35 crowns per square metre (exclusive of the preparation of the foundation and the supply of road metal).

If the traffic on a road exceeds 1,200 tons per day, it is necessary to choose a heavy surface (stone pavement, cement, tar or asphalt concrete surface, etc.). The species of fine pavement now much used costs between 80 and 90 crowns per square metre.

Locating Leak in Small Sewer

A simple method of locating a leak in the arch or upper half of a small sewer is suggested by Harrison P. Eddy, Jr., in a recent letter to the editor. Said he:

In an inspection of a 12-in. vitrified pipe sewer, reflected sunlight disclosed a pencil stream of ground water leaking in from the crown under some pressure. The sound of the falling stream was plainly audible in the manhole below. Its location, about 75 ft. away from the manhole, was impossible to ascertain by means of counting joints.

By attaching an ordinary tin can to a common sewer rod and pushing this up the sewer, the location of the leak was precisely determined by the distinct noise made when the stream struck the can. This noise, which reverberated through the sewer, was like that of a small boy's toy drum.

RECENT LEGAL DECISIONS

Highway Commission Held Not Compelled to Proceed With Road Improvement Although Approved by It

In a mandamus proceeding to compel the Kansas state highway commission to proceed in conjunction with a board of county commissioners to let contracts for the completion of a certain public road improvement to which the state commission had theretofore given its approval, the Kansas Supreme Court, State v. Commission, 273 Pac. 403, sustained the contention of the commission that notwithstanding its earlier action approving this road improvement and all it had done for that purpose, the matter still continued to be one wholly within its discretion and that it had discretionary power to refrain from carrying this road project to completion. In the absence of any charge of arbitrariness, abuse of discretion or bad faith, the court gave the commission the benefit of the usual rule of law that official duty or official conduct is always presumed to have been rightfully discharged, and the commission may have had excellent reasons for not going ahead with the road project. Three judges dissented, on account of the considerable burden of expense already incurred by the county on the faith of the commission's official sanction to the project.

Materials Necessary for Prosecution of Drainage Work Held Covered by Arkansas Contractors' Bond

The Arkansas Supreme Court holds, Leslie Lumber & Supply Co. v. Lawrence, 11 S. W. (2d) 458, that a drainage contractor's bond to pay all persons furnishing supplies and material for use in the work covers materials and supplies furnished the contractor for use in or reasonably necessary to accomplish the purpose of the work, and would cover material furnished for bunkhouses, tent forms, cement sheds, a shop, and a commissary if they were reasonably necessary for use in prosecuting the work, and cement and other material fabricated for the work and delivered to the contractor, although not actually used therein, because the work was stopped by the drainage district board, or for any other reason not due to the material furnisher.

Airport Held a Public and Municipal Purpose for Which City May Issue Bonds

The New York Court of Appeals, Hesse v. Rath, 249 N. Y. 435, affirming 224 App. Div. 344, holds that the acquisition of an airport or landing field by a city, under New York Laws 1928, c. 647, (amending General Municipal Law, article 14,) which authorizes the cities of New York state to establish, construct, equip, maintain and operate airports or landing fields for aeroplanes and other aircraft, and to regulate, by the local legislative body, the use thereof and establish fees and charges, is both a public and a municipal purpose within article 8, section 10, of the state Constitution forbidding cities to incur indebtedness except for city purposes, and that valid bonds might be issued therefor by the city of Utica.

Contractor Prevented From Finishing Water Reservoir Contract May Recover Damages But Cannot Compel Continuance of Work

Where the contract for the construction of a concrete water reservoir and its appurtenances was partly performed and the contractor was prevented by the municipality from performing the remainder, he was held entitled to the contract price for the part which he performed in accordance with the contract rate, and to damages for being prevented from completing the remainder; but he was not entitled to an injunction restraining the municipality from forfeiting and canceling the contract, since a contractor cannot compel a public body to continue the work of construction of a public improvement. Boyer v. City of Yakima, Washington Supreme Court, 273 Pac. 188.

Basis of Compensation for Land Condemned for City Waterworks

On condemnation of land for a reservoir for city waterworks purposes, the Oklahoma Supreme Court holds, City of Cushing v. Buckles, 273 Pac. 346, the present market value, and not the value to the owner or to the person seeking to condemn it, is the basis of compensation. Facts respecting the beneficial uses to which the land may be put, such as farming and mining, and also the circumstance that timber was growing thereon capable of being converted into lumber, may be introduced and considered, but only so far as they affect or shed light upon the market value of the land, and not for the purpose of having each of these beneficial uses furnish an item to be compensated for in addition to the value of the land itself.

Groceries to Workmen's Camp Held Covered by State Bridge Contractors' Bond

A state bridge contractors' camp, because of the isolated location of the work, was held a necessary, efficient means "for the carrying on of the work" of the construction of the bridge although it was managed exclusively by one of two firms, partners in the construction work; and groceries furnished to the camp were held within the contractors' bond furnished under the Washington statute to pay all persons supplying the contractor or subcontractors with provisions and supplies for the carrying on of the work. Macdonald Bros. & Metcalfe v. Maryland Casualty Co., Washington Supreme Court, 273 Pac. 192.

Injunction Refused of Road Contract Under Appropriation From Special Taxation

The Kansas Supreme Court holds, Young v. Board of Comrs. of Washington County, 273 Pac. 398, that individual taxpayers, proceeding under Kansas Rev. St. 60—1121 to enjoin public officials from making or carrying out contracts alleged to be invalid, can maintain such action only when it is shown that the contract will result in the creation of a public burden and the levy of an illegal tax, charge and assessment upon the plaintiffs; and taxpayers could not enjoin the making of a contract for the construction of a road under an appropriation from a gasoline tax and motor vehicle licenses.